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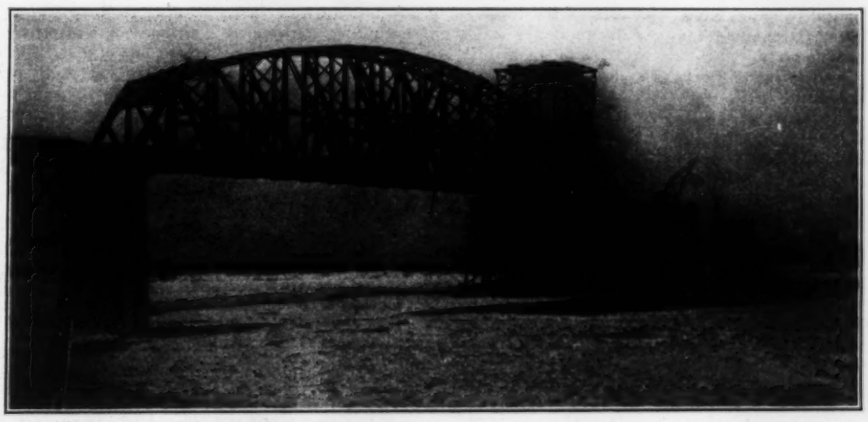
The Mississippi River Bridge at St. Louis for the Illinois Electric Traction System.

The bridge now under construction across the Mississippi River at St. Louis, Mo., for the Illinois Traction System is of interest not only as an important engineering structure but as being by far the largest and most important bridge ever built for an interurban electric railway. It is an indication of the remarkable development of such railways in this country. It forms a link in a railway system agregating about 550 miles, which serves a number of important cities in Illinois and has one of its main lines terminating at East St. Louis, Ill. The railway company realized the advantages that would result from obtaining direct access to St. Louis (across the river). After investigation it was decided that it would be a wise investment to construct a bridge and to establish terminal facilities (for both passenger and freight service) in St. Louis. It was decided also to provide for highway traffic across the bridge, thus obtaining a revenue from the tolls. Hon. Wm. B. McKinley, now a member of Congress, from the 19th Illinois District, is President of the Illinois Traction System, and Mr. H. E. Chubbuck is Vice-President and General Manager.



THE McKINLEY BRIDGE OVER THE MISSISSIPPI RIVER AT ST. LOUIS; DEC. 30, 1909.

On Dec. 31, the ice jam moved and carried away the falsework for the second span, together with the traveler.

(This view shows the traveler for erecting the steel span; also the traveling derrick and floating derrick and pile driver used in erecting the falsework. At the left is one of the 250-ft. deck truss spans with curved bottom chords.)

A separate company was organized, under the name of the St. Louis Electric Bridge Co., and Mr. Ralph Modjeski, M. Am. Soc. C. E., was appointed Chief Engineer, in charge of both the design and construction of the bridge. Mr. F. E. Washburn is Resident Engineer on the work. The contracts for the substructure and the erection of the superstructure were awarded to the Missouri Valley Bridge & Iron Co., of Leavenworth, Kan. The contract for furnishing the superstructure was awarded to the Pennsylvania Steel Co., of Steelton, Pa.

Construction was commenced in 1907, and the substructure work is completed. Up to March, 1910, one of the three large channel spans had been erected (at the west side), with the three adjacent shore spans, and a part of the western approach viaduct. The completed falsework for the second (middle) channel span was carried away by the ice on Dec. 31, 1909, causing the loss also of the traveler. Work was then started at the east end, for the erection of the shore spans and the two remaining channel spans. It is expected that the bridge will be completed by October, 1910. Fig. 1 shows the condition of the work on Dec. 30, the day before the carrying out of the falsework. It shows the completed span, the falsework, the main erecting traveler, and also the traveling derrick and floating derrick used in the construction of the falsework.

The river conditions, the triangulation surveys and the construction of the substructure were described very fully in our issue of Jan. 6, 1910, by Mr. F. E. Washburn, Resident Engineer.

The site selected for the bridge is at the northern part of the city of St. Louis, about ¾-mile below the Merchants Bridge (railway) and three miles above the Eads Bridge (double-deck railway and highway). The railway, of which the bridge is the principal part, extends from a connection with the line of the Illinois Traction System at Main St., in Venice, Ill., to a station at 9th and Salisbury Sts., in St. Louis, a distance of about 1½ miles. The station at the St. Louis end of the bridge will be a rather elaborate structure, costing about $60,000. This will not be the terminal, however, as the railway will extend about 2½ miles through the streets to some point in the business district, in the neighborhood of 12th and Lucas Sts. At this point the company will have a large freight, express and baggage station besides the passenger station. Freight yards with team tracks, etc., will be established under the St. Louis approach. Owing to the low ground on each side (and especially on the Illinois side) long approaches are required to attain the elevation necessary to give the channel spans a headway of 50 ft. above high water, as demanded by the War Department.

The bridge proper consists of three channel spans and five flanking or shore spans, as shown in Fig. 2. The main channel of the river is 1,500 ft. wide between the harbor lines established by the government, and the shore piers were required to be clear of these limits. This part of the river is crossed by three through-truss spans 517½ ft. long, c. to c. of end pins, giving three openings 500 ft. wide in the clear. The clear headway is 50 ft. for the middle span, reducing to 45 ft. at the shore piers of the two side spans. The two railway tracks are laid between the trusses, while two 13-ft. roadways are carried outside of the trusses by cantilever floor beams. On the Missouri side, there are three deck truss spans (one of 250 ft. and two of 150 ft.), followed by a 98-ft. deck plate girder span crossing the tracks of the Chicago, Burlington & Quincy Ry. In the Illinois side there are two deck truss spans of 250 ft. and 150 ft. respectively. The center span is level, with grades of 0.875% on the other through truss spans and 1.75% on the deck spans.

On both sides there are long viaduct approaches. The west approach has a length of about 2,600 ft. to the 98-ft. girder span mentioned above. Beginning at the street grade at 9th St., the line rises by a grade of 1.75% on a solid embankment with concrete retaining walls. This includes the station and extends to Broadway (about 330 ft.), which is crossed by a plate-girder bridge. Beyond this is a steel viaduct of 41-ft. spans, broken by two through-girder spans at street and railway crossings. The line is level for about 1,600 ft. from Broadway, and then rises on the grade of 1.75% which extends to the main channel spans.

The east approach will begin with a short bank and a pile and frame trestle 644 ft. long (14-ft. spans), at an angle with the center line of the bridge; beyond this will be ten steel viaduct spans of 39 ft. to 50 ft. in length, extending to the deck truss spans. This approach will be used temporarily for both the railway and the highway, but eventually there will be about 2,500 ft. of steel railway viaduct (with 41-ft. and 60-ft. spans) extending in a direct line with the main center line of the bridge and followed by

an embankment terminating at the street grade in Venice. The grade will be 4% on the timber trestle. On the steel trestle it will be 1.75%, broken near the middle by a level stretch. The total length of the permanent east approach will be about 3,050 ft., while with the temporary approach it will be about 1,400 ft. Thus the total length will be about 1.5 miles, as follows:

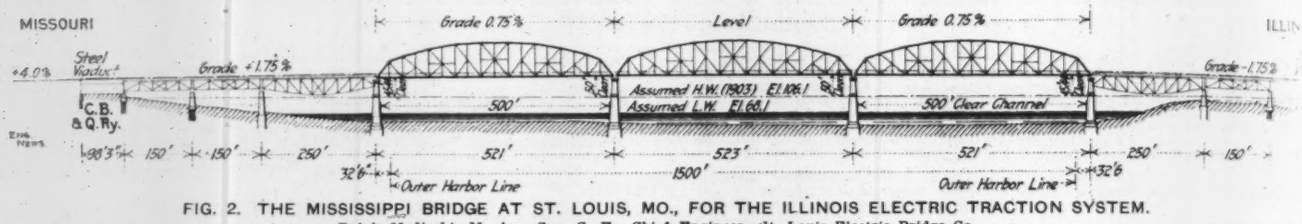


FIG. 2. THE MISSISSIPPI BRIDGE AT ST. LOUIS, MO., FOR THE ILLINOIS ELECTRIC TRACTION SYSTEM.

Ralph Modjeski, M. Am. Soc. C. E., Chief Engineer, St. Louis Electric Bridge Co.
(Missouri Valley Bridge & Iron Co., Leavenworth, Kan., Contractor for substructure and erection of superstructure; Pennsylvania Steel Co., Steelton, Pa., Contractors for superstructure.)

3 channel spans, 1,565 ft., 5 shore spans, 950 ft.; east viaduct approach, 3,050 ft., west viaduct approach 2,600 ft.

While the load requirements for an electric railway bridge would be considerably lower than for a steam railway bridge, due to the absence of the heavy concentrated loads on the driving axles of locomotives, it was decided to design the bridge for the latter loads with a view to the possible future use of the bridge for steam railway service. In order to reduce the first cost, however, some of the members have been made lighter by omitting certain parts which can be applied readily whenever conditions arise making it desirable to provide for steam railway traffic. In the three long spans, the trusses are built of full strength for locomotive loading, but the floor-beam construction omits the flange cover plates which will be required to strengthen the floor system for carrying locomotives.

The assumed live load for electric railway service consists of 75-ton electric interurban cars 40 ft. long; truck wheelbase, 6 ft.; total wheelbase, 31 ft.; distance between axles of adjacent cars, 9 ft. For future steam railway use (with structure strengthened), the assumed live load is 5,000 lbs. per ft. of track and 50,000 lbs. concentrated load for floor when strengthened. The load on the trusses is 20% less, on account of the double track. The assumed live load for the roadways is 100 lbs. per sq. ft., or a 35,000-lb. steam road-roller. The wind load is taken as follows: 600 lbs. per lin. ft. on the loaded chord, half of this as live load; on the unloaded chord, 250 lbs. per ft. for the through spans and 200 lbs. for the deck spans; on the approaches, 250 lbs. per lin. ft., as live load. The provision for impact is represented by from 30% to 50% reduction of the unit stress for live load.

The material is medium open-hearth steel, having an ultimate tensile strength of 62,000 to 70,000 lbs. per sq. in., an elastic limit of 37,000 lbs., and an elongation of 22% in 8 ins. The same specifications apply to the specimen tests for eye-bars, but tests of full-sized bars must show 57,000 lbs. per sq. in. ultimate strength, 30,000 lbs. elastic limit, and 12% elongation in 20 ft. The steel for the pins must have 62,000 to 70,000 lbs. ultimate tensile strength, 35,000 lbs. elastic limit, and 20% elongation in 8 ins. The expansion bearings are fitted with segmental rollers. In the main spans, all holes for the floor beams and cantilever bracket connections to the truss posts are reamed to an iron template. The rivets are mainly ⅞-in. diameter, in 15/16-in. holes. The holes are punched with a ¾-in. die, and reamed to size. All sharp and protruding edges of the holes are removed, and the edges are filleted for the rivet heads.

The material is given a coat of oil at the shops, and two coats of Nobrac paint after erection, the final coat being of olive color.

CHANNEL SPANS.—The three main channel spans are identical in construction. The general design is shown in Fig. 2, and the details of one of the trusses are shown in Figs. 3 and 4. They are 517 ft. 6 ins. c. to c. of end pins; with trusses 78 ft. deep at the center, and spaced 29 ft. 8 ins. c. to c. The top chords and end posts are 33⅛ ins. deep and 44 ins. wide over the cover plates, and are of very heavy and rigid construction. They have four built-up webs connected by diaphragms and having four lines of flange angles at top and bottom; a continuous cover plate ½-in. thick is riveted to the top flange angles, while across the lower angles are riveted batten plates and single lacing bars. The bottom chord is of similar section in the first two panels at each end, while in the other panels it is composed of 14-in. eyebars from 1½ ins. to 1¾ ins. thick.

The panel length is 28 ft. 9 ins., with main posts and diagonals of double channel section (with flanges inward for posts and top sections of diagonals), built up of two side webs and four angles. Across the angles (transverse to the line of the bridge) are tie plates and single lacing angles or double lacing bars according to the width of the member. The longitudinal struts and the posts above intersection points are of box lattice section, with four angles laced on all sides. All pin connections are made with 12-in. pins, except that 6-in. pins are used for the end-post struts.

The floor beams between the trusses are plate girders, having their ends riveted to connection plates or gussets on the posts. Between these are four lines of plate-girder track stringers 16 ins. deep and spaced 6 ft. apart. In line with the floor beams are triangular cantilever brackets

for the roadways, and between these there are two lines of 31½-in. stringers. The floor beams and cantilever brackets are connected at top and bottom across the trusses, so as to form rigid continuous members.

The details of the floor beams and floor construction are shown in Figs. 3 and 5. For the track floor, there are ties 8 × 8 ins., 10 ft. long, laid upon the stringers and spaced 7 to 7½ ins. apart. Every third tie is secured to the stringer flanges by hook bolts. Every fourth tie is 11 ft. long. Outside guard timbers 8 × 8 ins. (boxed 1½ ins.) are placed 4 ft. 4 ins. clear from the center of the track, and secured to each third tie by a ¾-in. bolt. The inside guards are timbers 5 × 8 ins. (not boxed), placed 8 ins. clear from the rails and secured to every tie by a ⅞-in. bolt.

For each roadway there are the two steel stringers and also five lines of timber joists 8 × 16 ins. These joists rest on angle brackets and are supported at each mid-panel point by a transverse 15-in. I-beam secured to the webs of the stringers and forming a sub-beam. This arrangement is shown clearly in the cross sections of the deck spans, Fig. 5. The floor system of the roadway supports the Shuman sectional wood-block paving, which consists of blocks about 3 × 4

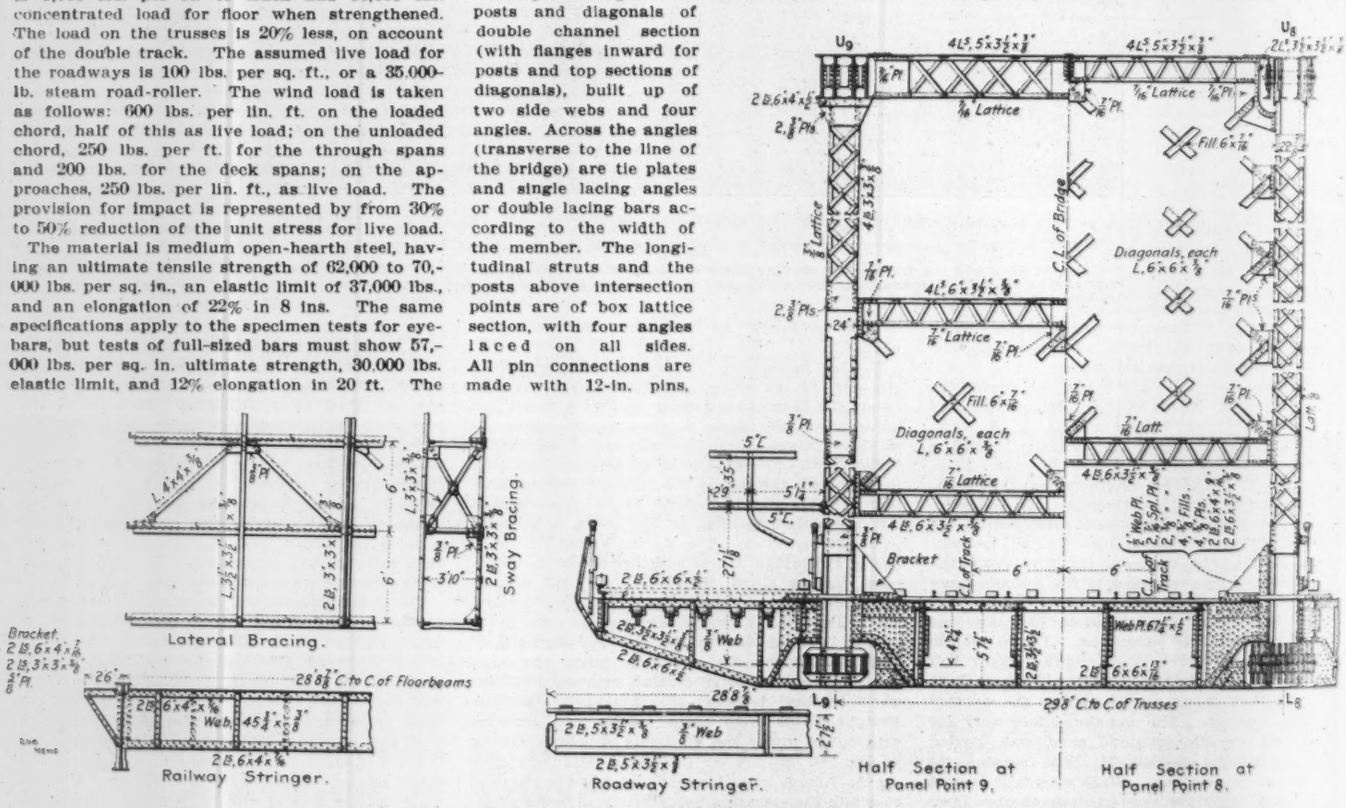


FIG. 3. DETAILS OF CHANNEL SPANS.

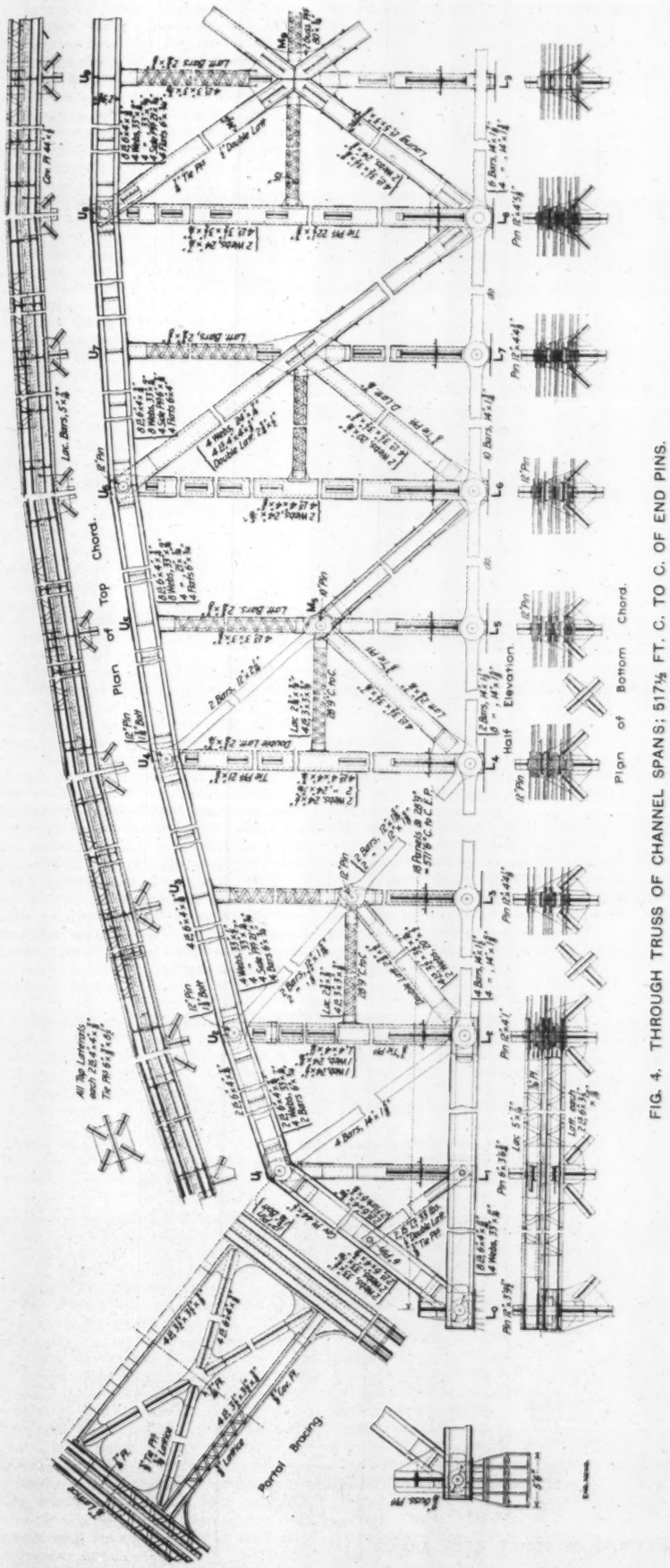


FIG. 4. THROUGH TRUSS OF CHANNEL SPANS; 517½ FT. C. TO C. OF END PINS.

ft. formed of planks 1 × 3¾ ins. set on edge and bolted together. The planks are dipped in a bituminous composition, and the joints between the blocks are filled with roofing pitch. This paving was described in our issue of Sept. 24, 1908. On each side of the floor is a guard timber 6 × 8 ins., blocked 1½ ins. above the floor to allow for drainage. Standards of 3-in. channels, with angle braces carry a pipe handrail and a plank which forms a hub guard.

The trolley wires for the railway are suspended from the struts of the overhead lateral bracing, which bracing gives a clear headway of 22 ft. from base of rail (21 ft. 7 ins. above the heads of the rails).

250-FT. DECK SPANS.—These two spans have panels 30 ft. 8 ins. long. They have pin-connected trusses with curved bottom chords composed of eyebars and the depth at middle of span is 40 ft. The construction is shown in Fig. 6. The fixed end bearing of each truss rests in a recess in the pier carrying the channel span. This end of the span has no end floor beam, but the stringers for the end panel extend from the floor beam to a bracket on the end floor beam of the channel span. The expansion bearing rests on top of the shore pier, and at this end there is a post of box section carrying an end floor beam.

150-FT. DECK SPANS.—These three spans are in general similar to the 250-ft. spans, but with parallel chords and a truss depth of 28 ft. 1½ ins. The panel length is 24 ft. 5½ ins. The end posts are inclined, but vertical posts seated on the shoes carry the end floor beams, as in the 250-ft. spans, and as shown in Fig. 7. This cut shows also the arrangement of the floor system for all the deck truss spans.

APPROACH VIADUCTS.—These viaducts have four-post bents; the two inner posts (carrying the railway) are composed each of two 15-in. channels and a 15-in. I-beam forming a diaphragm. Batten plates are riveted across the flanges of the channels. The outer columns are of 12-in. channels and lacing bars. The spans are generally 41 ft.; three 50-ft. spans are used on the Venice side. The tower spans, averaging every fourth span, have longitudinal diagonal bracing and horizontal bottom bracing. The viaduct construction is shown in Fig. 8. There are four lines of plate girder stringers, and two lines of deck trusses over the outer columns.

TROLLEY WIRE SUPPORTS.—On the deck truss spans there are steel posts (built up of four angles) at mid-panel points, carrying transverse 6-in. channels from which the trolley wires are suspended. On the top of each post is a steel cross arm for telegraph and telephone wires. A similar construction is employed on the viaduct approaches, the posts being spaced about 82 ft. longitudinally. On the through spans, the wires are carried by the bottom struts of the lateral bracing, which give a clear headway of 21 ft. 7 ins. above the heads of the rails.

CONSTRUCTION PLANT AND ERECTION.—The methods and plant used in the erection of a structure of this kind are of particular interest and for the information as to this part of the work at the St. Louis Bridge we are indebted to Mr. F. E. Washburn, Resident Engineer.

The main storage yards for steel were located on the west side of the river, along the bridge approach, between the Chicago, Burlington & Quincy Ry., and the Merchants Bridge Terminal Ry. This area was traversed by three unloading tracks, between which two 20-ton derricks were so located as to make the best use of the available space. Each derrick had a 60-ft. boom and 65-ft. mast of Oregon fir 17 ins. diameter. The boom was reinforced with steel rods trussed at the center to a depth of 7 ins. in both planes. The mast and boom seats were formed in a single casting which engaged the mast for a depth of 12 ins. and was supported on a step having a base 29 ins. square. The upper part of the mast top consisted of metal 9 ins. thick which supported a 3½-in. pin upon which the spider plates were fastened. These spider plates were equipped with four 2½-in. pins to which guy lines of 1⅜-in. cable were attached.

The rigging was attached to a 2¼-in. Norway iron link which was secured to the mast top by a 2¼-in. stirrup. The boom top was a solid casting engaging the timber for a depth of 12 ins. It supported a 17-in. sheave on a 3-in. pin. To this pin were connected stirrups of two 3 × 3¾-in. eyebars, 3 ft. long, and two eyebars 4 ft. long. The former stirrup connected to a four-sheave block with a 2½-in. pin for the boom falls, and the latter engaged a three-sheave block for the main falls.

A third derrick was so situated that it could be used for hoisting steel to the viaduct, from which it could be transferred on cars to its place in the structure. This derrick had a capacity of 40 tons, this being sufficient to raise the heaviest member handled. This derrick was of steel, with a 65-ft. mast and 40-ft. boom. It was erected, by means of a gin pole, upon a pile foundation 10 ft. square, heavily cross braced and connected. The mast was guyed with three 2⅛-in. cables attached in a similar manner to those for the 20-ton derricks. Each cable was fastened to an 18-in. pile head which rested on blocking about 300 ft. from the mast. The blocking and pile were held firmly in place by two 1⅞-in. steel rods, 23 ft. long, which were anchored to a deadman about 10 ft. below the surface of the ground. The boom falls consisted of 14¾-in. lines operating in 20½-in. steel sheave blocks, and the main falls consisted of 10¾-in. wire lines with similar sheaves. The derrick was operated by a 30-HP. hoisting engine with three drums.

A 10-ton derrick car was used for shifting the cars, for unloading, and for handling light material. This car was equipped with an A-frame derrick having a 12 × 12-in. boom 41 ft. long. The A-frame was made of 12 × 12-in. timbers, and its height was limited by the clearance necessary for transportation. It was capped with a steel hood to which were fastened two 2-in. Norway iron rods which extended to the rear of the body of the car. The top of the A-frame and boom were connected to the rigging by two 1¾-in. iron rods. The boom rigging consisted of two 18½-in. four-sheave blocks and ¾-in. wire rope. The main rigging consisted of two 18½-in. triple-sheave blocks with ⅝-in. wire rope.

The derricks were erected with gin poles and the 40-ton derrick was used to erect three spans of the viaduct after the girders (98 ft. 8 ins. long) for the crossing of the C., B. & Q. Ry. tracks had been placed on trucks beneath the center of the viaduct. A gin pole was erected at the west side of the tracks for the erection of a gallows frame by means of which the posts were erected for the bearings of the girders, these posts being cross braced to the adjacent span of the viaduct. This gallows frame was used to erect the first bent of the traveler on the east side of the tracks. The second bent of the traveler was then erected and the posts and cross girder for the east support of the girder span were placed in position. A temporary track was laid across the tracks of the C., B. & Q. Ry. upon which the girders were run out and raised to position. The weight of each girder was 40 tons. The complete erection of the span occupied 1 hr. 10 mins., and was done on June 22, 1909. This is shown in Fig. 9.

A 10-ton derrick traveler was then erected upon the viaduct and the work proceeded in both directions (as shown in Fig. 10, with the traveler for the deck truss spans at the right). The boom of this derrick was of sufficient length to erect material at a distance of 41 ft. or one span length. The traveler used for the erection of the 150 ft. and 250 ft. deck spans is shown in Fig. 11, on one of the shorter spans. It was 75 ft. 6 ins. high, from top of sill to top of truss, 50 ft. wide at the top and 31 ft. at the bottom. The clearance between legs of traveler was 29 ft. 4 ins. The inside vertical posts were 8 × 10 ins. and the outer battered posts were 6 × 10 ins. The legs were divided in panels from 6 ft. to 12 ft. high, cross braced with 2 × 10-in. timbers. The truss was 10 ft. deep, with 3 × 12-in. web members. The two bents were connected with 3 × 12-in. longitudinals which divided the height into three panels, diagonally braced by 3 × 10-in. timbers. Each side of the traveler

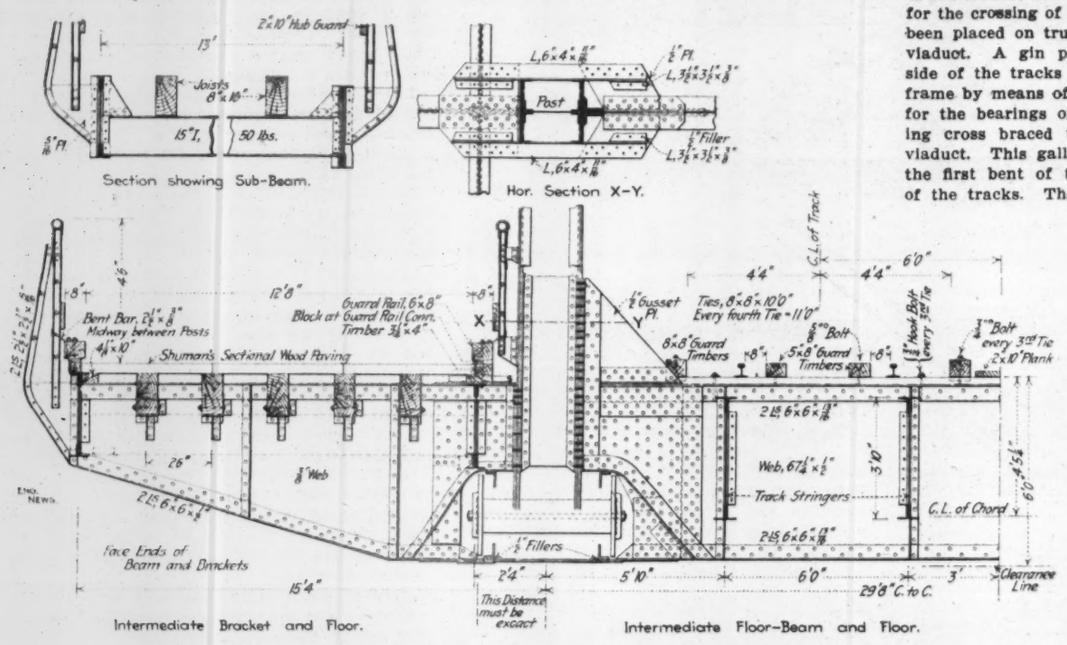


FIG. 5. DETAILS OF FLOOR CONSTRUCTION FOR THROUGH-TRUSS CHANNEL SPANS.

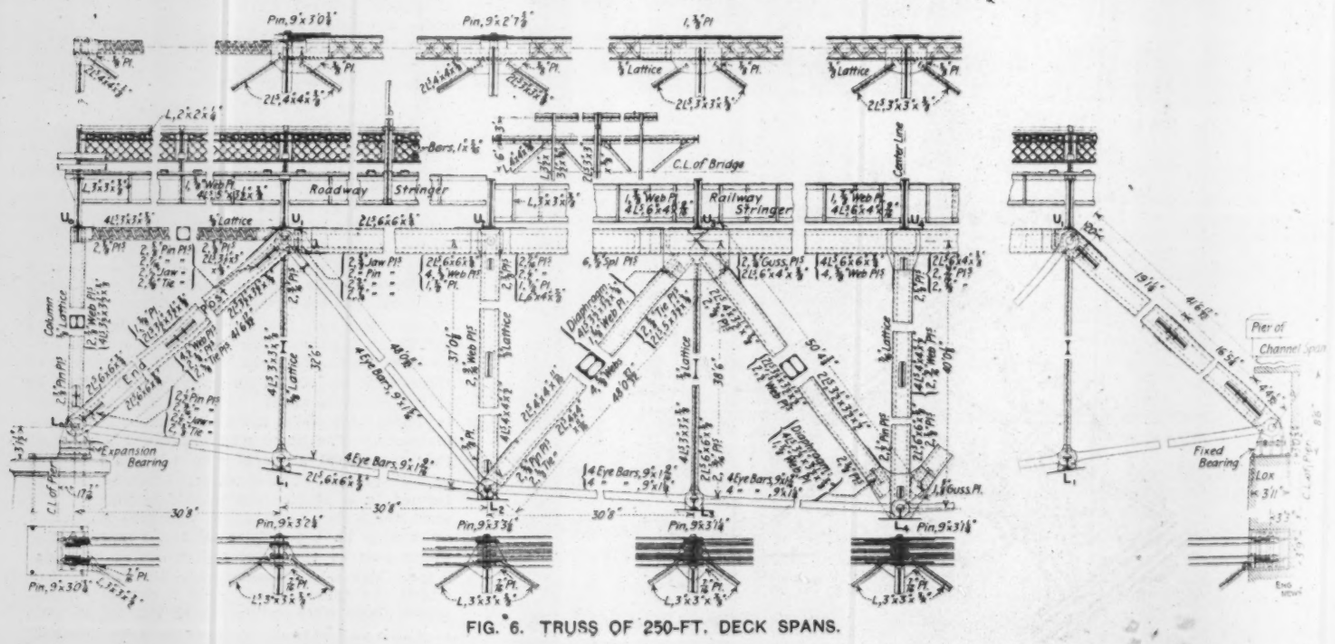


FIG. 6. TRUSS OF 250-FT. DECK SPANS.

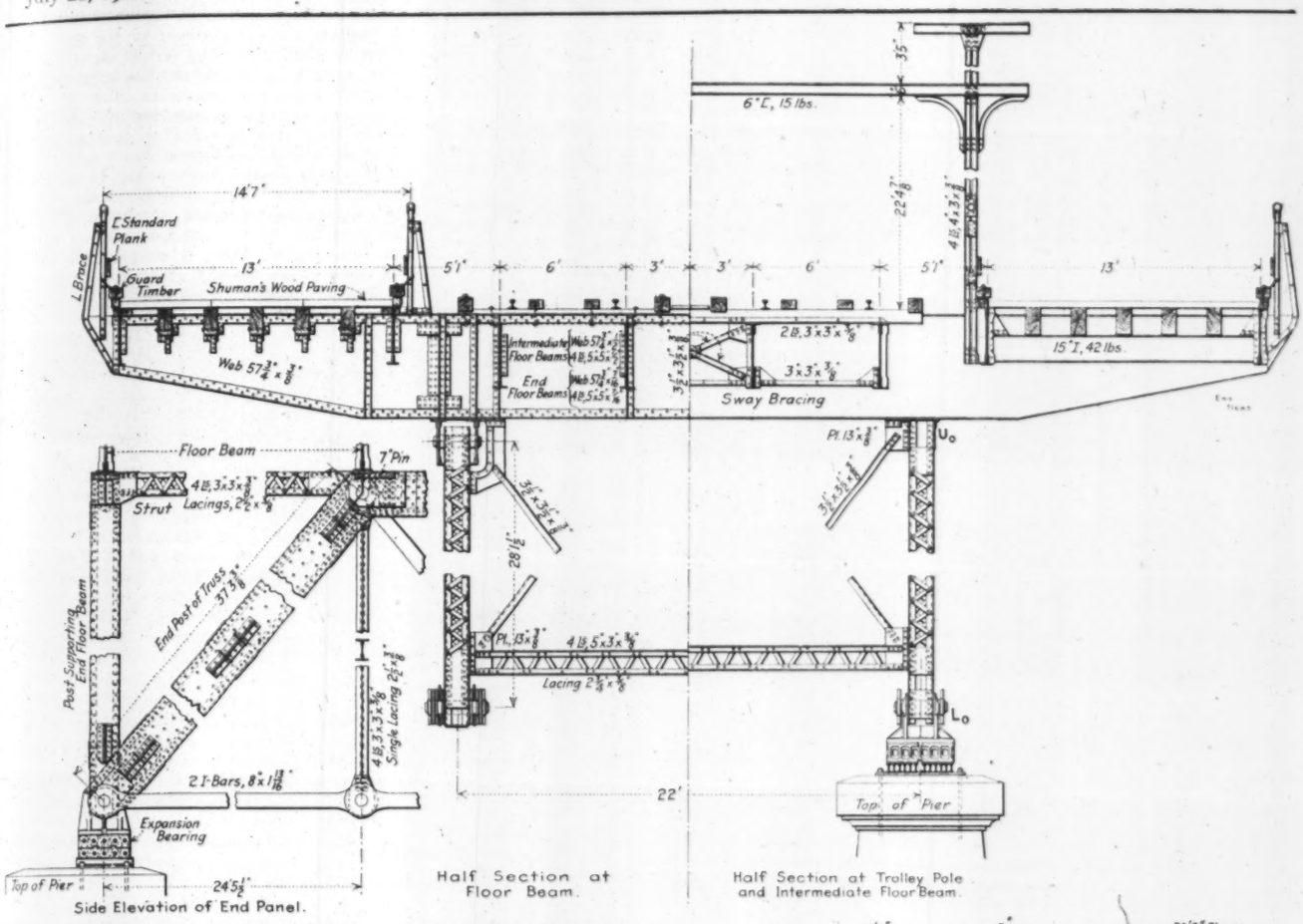


FIG. 7. CROSS SECTIONS OF DECK SPANS (250 FT. AND 150 FT.)

was supported on two wheels between two 8 × 16-in. sills.

The falsework for the 150-ft. spans (Fig. 11), consisted of one-story framed bents resting on cribbing or piling. There were six piles to a bent and six 12 × 12-in. posts in each framed bent, with 3 × 10-in. cross bracing. The pile caps were two 12 × 12-in. timbers spliced at the center, and the upper caps were similar timbers 18 ft. long, the two outer posts being battered. Three lines of 12 × 12-in. stringers were run out on the pile caps and upon these the bents were framed and raised to position by a hoisting engine placed on top of the pier. Three lines of 8 × 16-in. stringers were then laid for the support of each truss and traveler rail. Material was delivered to the traveler by means of a 10-ton derrick car. A pony bent was erected at the end of the first span erected, and the floor was laid to enable the derrick to lower material onto a push car on top of the falsework by which transfer was made to the traveler. This derrick was used also for erecting the floor after the trusses were swung.

The falsework for the 250-ft. spans consisted also of one-story framed bents resting on pile bents. There were seven piles to a bent and eight 12 × 12-in. posts to each framed bent. The piles were cut off on a grade corresponding to the curved line of the bottom chord of the truss. The cap of the framed bent was supported at the required elevation for each panel point by four of the posts, and the other posts were made of sufficient height to support the traveler track on a 1¾% grade. The original design for falsework contemplated the raising and lowering of the traveler with jacks a distance of 12 ft., so that the traveler track would be at the elevation of the lowest point of the bottom chord. The method used, however, dispensed with the jacking of the traveler and with the great amount of blocking which would have been necessary under the original plan. Three lines of 8 × 16-in. stringers were used for the support of each truss and each traveler rail.

The end bearings at one end of the trusses were set in niches in the side of the pier and the erection at this point required the assembling of the members with the shoes before placing same in the niches. Temporary bracing was required to support the trusses during erection before the floor system was placed. The traveler was dismantled by means of a derrick car on the completion of the work on the west side of the river, and it was reframed as a three-bent traveler for the remainder of the work.

The falsework bent for the 517½-ft. span was supported on 14 piles which were cut off about 20 ft. above low water. The piles were from 40 to 65 ft. long and were driven to an average penetration of 1-in. with a steam hammer. The average depth to which they were driven was about 20 ft. The width of bent at top of piles was 64 ft., the piles being spaced from 3½ ft. to 6 ft. centers. The piles were capped with two timbers 12 × 12 ins., upon which was erected a three-story framed bent. Each story was 19 ft.

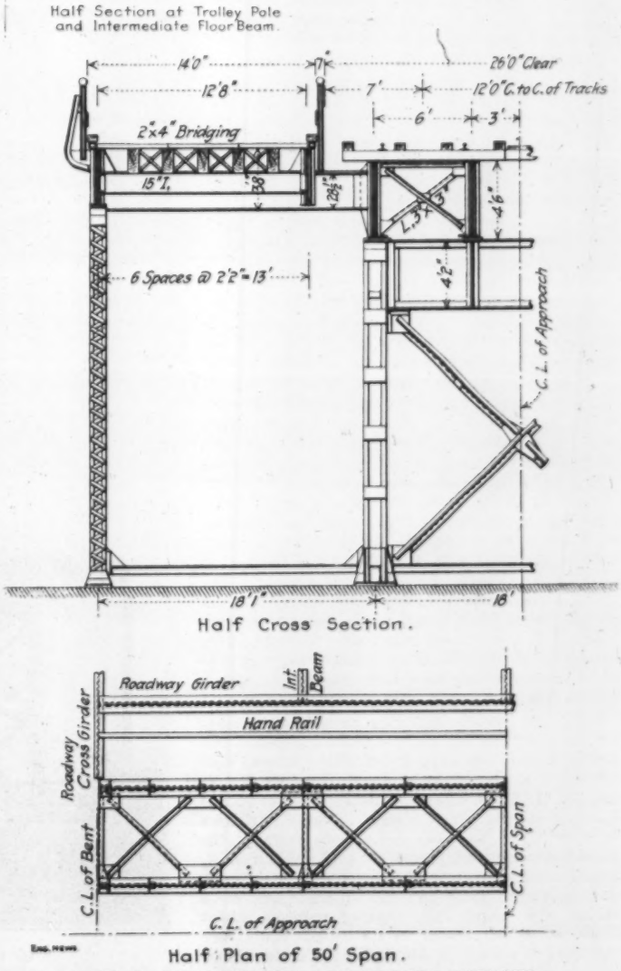


FIG. 8. CROSS SECTION OF APPROACH VIADUCTS.

8 ins. in height and was capped with a 12 × 12-in. timber. It was composed of a section for the support of each truss, which consisted of five posts 12 × 12 ins. diagonally braced with 2 × 12-in. timbers. The two outer posts of each section were battered, and the width at the top of the falsework was 48 ft. 8 ins. between centers of posts.

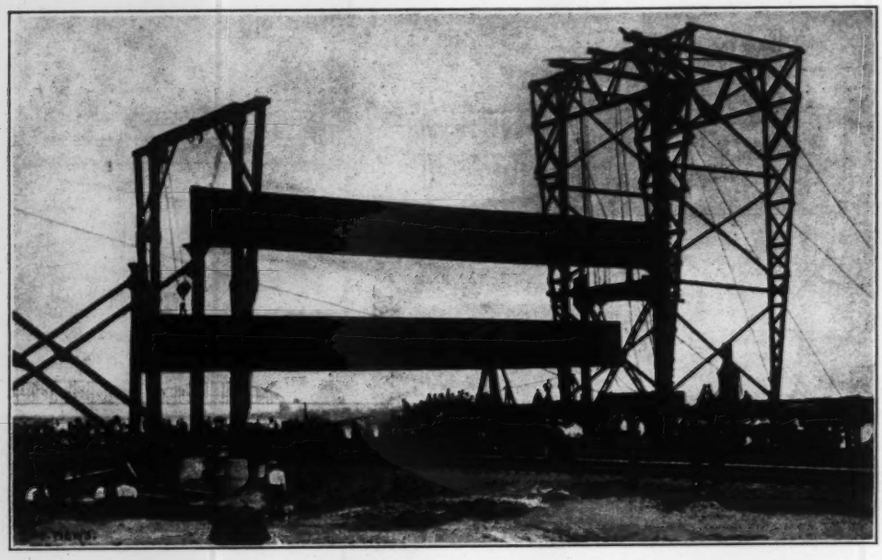


FIG. 9. ERECTING 98½-FT. PLATE-GIRDER SPAN OVER THE CHICAGO, BURLINGTON & QUINCY RY. FOR THE APPROACH TO THE NEW MISSISSIPPI RIVER BRIDGE.

Diagonal bracing between bents was provided in the first and second and fifth to eighth panels from the center, there being four 3 × 10-in. braces per panel, doubled at the center panels. Longitudinal bracing between bents consisted of four 10 × 12-in. timbers above each cap. There were four lines of 8 × 16-in. stringers under each truss, and six under each traveler track. The falsework bents were erected by a 10-ton mule traveler operating on the top of the falsework. The stories were framed on a barge, on which they were delivered within reach of the traveler boom and raised to position, as shown in Fig. 1.

A three-bent traveler was used for the erection of the 517½-ft. spans, and the construction of this is shown in Fig. 12. The height from top of sill to center of the upper cap was 99 ft. 6 ins. and the total width c. to c. of inclined posts was 64 ft. 8 ins. at the top and 47 ft. 2 ins. at the bottom. The clear span of the traveler was 37 ft. 2 ins. and the clear height above sill was 87 ft. The width of leg at the sill was 5 ft. and this width increased to 13 ft. at the top, the outer post being battered. The inner posts were 10 × 14 ins. and the outer ones 6 × 14 ins. Each leg was divided into eight panels, varying in height from 8 to 15 ft., with 3 × 12-in. diagonal bracing. The upper chord of the truss was composed of two 7 × 16-in. and the lower chord of two 7 × 12-in. timbers, with 4 × 12-in., 4 × 10-in., and 7 × 12-in. timbers for the web system. The bents were connected by 10 × 10-in. timbers, spaced about 24 ft., each panel having diagonal bracing of 1-in. round iron rods. The sills were composed of four 8 × 16-in. timbers on each side of the traveler, and were supported on six wheels which ran on a track of 5 ft. gage.

The bents were braced diagonally in a horizontal plane at the top by 3 × 10-in. timbers. The stringers for the support of the rigging were composed of two lines of double timbers 8 × 20 ins., 29 ft. 8 ins. apart, a distance equal to the spacing of the steel trusses. These stringers were centered over two 7 × 12-in. posts in the wooden truss which rested on a 12 × 12-in. horizontal block above the bottom chord. This block was supported from the top of the truss by a 1¾-in. iron rod. The traveler required about 58,900 ft. B. M. timber in its construction, representing a weight of 118 tons; the bolts, washers, rods, and angles amounted to 6 tons, and the 12 wheels and boxes 1½ tons, making a total weight of 125½ tons. It was wrecked when the falsework was carried away by the ice, and a new one was built for the other two spans.

Each side of the traveler was rigged with a runner and cable falls at each end, a center runner and two middle falls. The cable falls were triple-sheave blocks rigged with ⅞-in. cable running through two extra sheaves and two snatch blocks. The runners were 1¾-in. lines operating through single sheaves. The middle falls were triple-sheave blocks rigged with 1⅛-in. lines running through two extra sheaves and snatch blocks. The lines for each side of the traveler were operated by a 60-HP. hoisting engine with two cable drums and four winches.

The main traveler described above was erected by a novel method originated by Mr. W. O. Burkey, the superintendent of erection, and his assistant, Mr. Chas. Tupper. After the falsework was erected for a distance from the first main pier equal to the height of the traveler, the three bents were framed in an inclined position on this at an angle of about 6° with the horizontal. A trip bent about 40 ft. high was then erected in a vertical position with its base resting on the foot of the first bent of the traveler. This trip bent was connected to the main traveler bent by two inclined timbers fastened to the top of the former and about midway of the latter.

The hitch to each traveler leg was made at three points, so selected as to cause the least amount of racking of the timber. A double sheave block was attached at the intersection of the main post and bottom chord of the truss and a single sheave block about 15 ft. lower, the becket being about midway of the traveler leg. A three-sheave block was attached to the steel structure already erected west of the pier and through this block a six-part 1¾-in. line was run over the top of the trip bent to the connections on the traveler leg above described. The lead line passed through a snatch block to the hoisting engine located about 125 ft. from the trip bent.

Blocks of wood rounded and smoothed were placed at the top of the trip bent to reduce the friction tending to vary the strains in the lines. This friction was gradually reduced by the rotation of the bent as the travel of the lines were being adjusted until the traveler was raised a sufficient amount to free the bent and allow a direct constant pull on the lines. Care was taken to keep the hoisting engines working together so that the traveler bent would be raised as a plane. The second and third bents were raised by lines passing through blocks which were fastened to the bents previously erected, the hitch in each case being similar to that for the first bent.

Flat cars operated by a light locomotive were used to deliver steel to the traveler, and erection of the trusses was carried on simultaneously at both sides of the span. Erection was begun at the center of the span and the panels completed for one-third the distance to one end. The bottom chord and web members were then erected to the end of the span after which the top chord was completed; erection was resumed at the center, and completed in like manner for the other half of the span.

Two 20-ton hoisting gibs were used in raising each top chord section. Each gib was composed of two channel girders connected with two 2-in. rods so fastened that they could be removed for adjustment of the gib to the chord section. The top chord of the gib supported two 2-in. pins to which a 1¾-in. hoisting ring was attached. The truss pins were driven with a steel ram 6 ins. diameter and 12 ft. long. A wooden float or platform was raised between the trusses for the support of the men during the driving of the pins of the upper chord.

THE INSTALLATION OF A ROAD-SPRINKLING system in the Yosemite National Park, Cal., at an expense of $12,000, has been authorized by Congress. The sum will be available for material and labor during the fiscal year 1910-11.

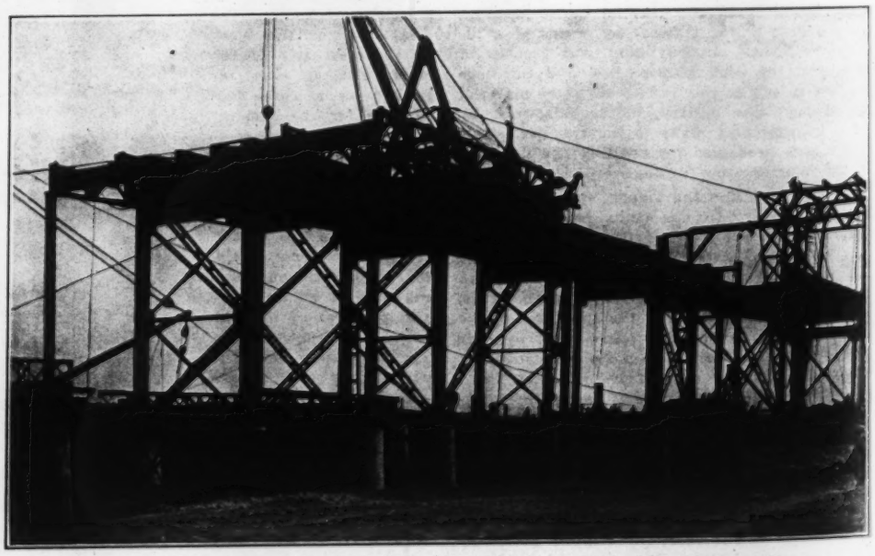


FIG. 10. ERECTING OF VIADUCT APPROACH WITH DERRICK CAR.

Proposed Structures to Prevent Future Damage from Floods at Paris.

The commission of engineers appointed immediately following the disastrous floods in Paris of last winter (Eng. News, March 4, 1910, p. 327) has brought in its preliminary report. This report first provides for a complete organization covering the entire drainage area of the Seine, a commission which is to be composed of engineers from that district, and whose duty it shall be to study and report upon the conditions in that valley. With such an organization the future provisions to care for floods will be in much better shape than it was at the time of the recent flood. In addition to this suggestion, the main recommendations concern the treatment of the Seine and its banks through Paris. This treatment comprises the widening of the small arm of the Seine above the Pont St. Michel, the reconstruction of three bridges, the removal of the railway near the Pont St. Michel, the modification of the Monnaie Dam and Lock, the raising of the quay walls some 2 ft. above the flood height of 1910, and the closing of the openings into the railway tunnels adjacent to the river. Besides these structural changes, the sewers of the city are to be provided with valves to prevent the running back of the water into the sewer system and additional collectors are to be built. It is recommended that the subways be specially waterproofed throughout their whole length, and also that at the Austerlitz station a movable dam be built to keep any rising water from entering the subway at that point. In order to allow a larger channel for the river, the left arm of the Seine by the side of the Ile de la Cite is to be widened. The bed of the river between Suresnes and Bougival is to be deepened, and a canal is to be built from Annette on the River Marne to Epinay-on-the-Seine. This latter is a by-pass canal around Paris so as to carry away some of the flood water around the town. The question of replanting the forests above the river was discussed by the commission, but the enormous expense of such a proceeding and the long period that would intervene before any relief could be expected were responsible for the absence of any recommendation for replanting the forests. The chairman of the commission, Mr. Alfred Picard, holds that the deforesting of the Upper Seine is somewhat responsible for the enormous floods, and suggests that it might be desirable to offer some bonus to land owners to preserve and to plant trees.

In all these recommendations, those of our readers who followed the description of the flood given in our pages last winter will recognize that the very evidently necessary protection to the riparian structures, such as sewers and open subways, has been provided for in the report of the commission.

THE WORK OF THE NEW U. S. BUREAU OF MINES

(see Eng. News, July 14, p. 50, for act creating bureau) for the ensuing year is outlined as follows in a statement issued by Mr. Geo. Otis Smith, Acting Director:

The work of the Bureau of Mines for the first year will be a continuation and expansion of the work carried on by the Technologic Branch of the Geological Survey. The law in itself provides for a variety of other problems that properly belong to the Bureau of Mines and which should eventually be undertaken, such as methods of mining and metallurgical processes, but these activities will be deferred for the most part until Congress gives additional authorization in the shape of adequate appropriations. The spirit of the debates in Congress both on the Bureau of Mines legislation and on the appropriation items emphasized the desire to regard the mine accidents investigations as urgent and this will be the feature of the work.

In all, $310,000 was appropriated for mine accident investigations. Of this sum, under the general plans approved by the Secretary of the Interior, $120,000 is to be spent on the rescue stations, $36,000 for housing nine stations; $34,000 for equipping eight new stations; and $10,000 for additional equipment for five existing stations. The allotment for the investigation of explosives is $40,000; for electricity in mining, $14,000; appliances for preventing mine accidents, $8,000; examination and codification of mining laws, $5,000; and other technologic investigations, ore treatment, etc., $10,000. For the analyzing and testing of the coals, lignites, ores, and other mineral fuel substances belonging to or for the use of the United States, $100,000 was appropriated. Of this amount, $35,000 will be spent in the chemical and physical investigation of fuels; $25,000 in the inspection of government fuel purchases; $22,000 in fuel efficiency investigations; $5,000 in lignite and peat investigations; and $4,000 in briquetting investigations.

Some of the earlier work along the same general line is thus summarized by Mr. Smith:

The mine accident investigations, which have been transferred from the Geological Survey to the Bureau of Mines, were first authorized in the legislative appropriation act of May 22, 1908, carrying for this purpose an appropriation of $150,000. This was followed by a similar appropriation carried in the act for the sundry civil expense of the government for 1910. A mine experiment station was established in Pittsburg during 1908, at which, since that time, investigations of explosives, coal gas, dust, electricity and other possible causes of mine explosions have been continually under way. The mining engineering field force of the Geological Survey has already made decided progress in the study of underground mining conditions and methods. Practically all of the coal mines in which mine explosions have occurred during the last two years have been carefully examined, the gases, coke and dust have been analyzed at the laboratory at Pittsburg and every effort has been made to determine the explosibility of various mixtures of gas and air in the presence of shots of different types of explosives. Considerable progress has also been made in the investigation of explosives used in coal mining, and the conditions under which they may be used with least risk. Manufacturers have submitted many explosives for test at the station and a considerable portion of them passed and have been classified among the permissible explosives. The investigations and educational work in connection with the use of artificial breathing and other types of mine rescue equipment, the so-called oxygen helmets, have not only been useful in developing a more satisfactory use of such equipment in the examination of mine explosions, but also better methods for using this equipment in mine rescue work.

The fuel investigations under the Geological Survey and which are transferred to the Bureau of Mines have already resulted in a better realization throughout the country as to the value of fuels. One result of this work is that nearly all of the fuel now purchased by the federal government is bought on specifications and subject to test by the fuel division, or purchased after examination made of the coal supplied by the mines from which coal is delivered to the government.

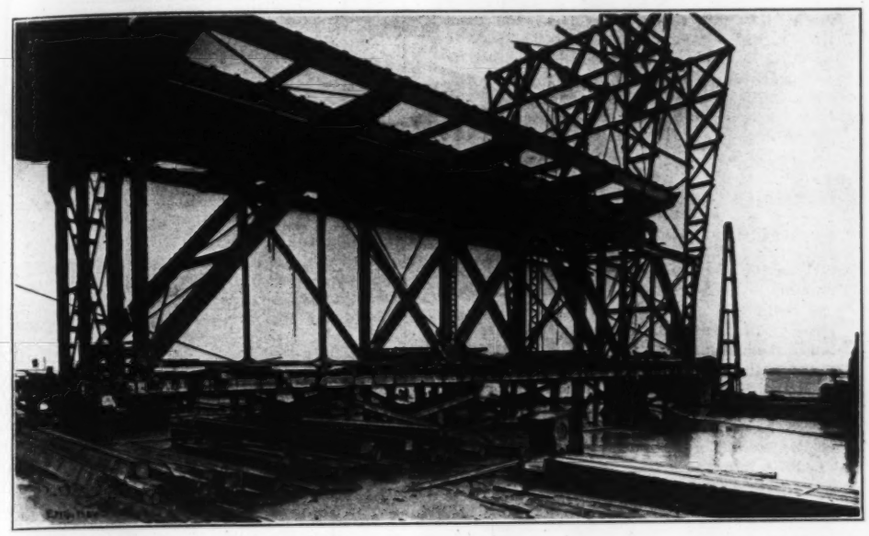


FIG. 11. 150-FT. DECK SPAN ON FALSEWORK, WITH TRAVELER USED IN ERECTION OF DECK TRUSS SPANS.

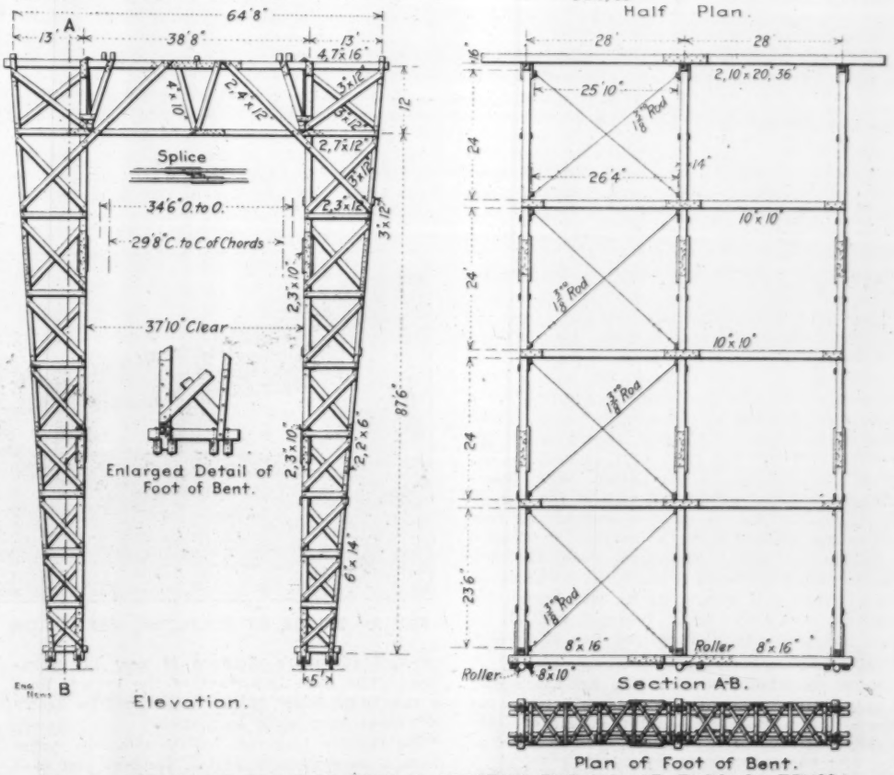


FIG. 12. DETAILS OF TRAVELER USED IN ERECTING THE 517½-FT. THROUGH TRUSS CHANNEL SPANS.

The Southern Pacific of Mexico Railroad.

By L. A. WATERBURY.*

There is now rapidly nearing completion a railway system along the western coast of Mexico which will connect the City of Mexico with the western portion of the United States. This project is one of the enterprises instituted by the late E. H. Harriman, and has been carried out under the direction of Colonel Epes Randolph, President of the lines now known as the Southern Pacific of Mexico. The map (Fig. 1) shows the general location of the route from the international boundary to the City of Guadalajara, which is the terminus of the line under construction, the City of Guadalajara already being connected with the City of Mexico by the Mexican Central Railroad.

Fig. 1. Map of Portion of United States and of Mexico Showing the Line of the Southern Pacific, of Mexico R. R. and Connecting Lines.

The main line of the new system crosses the international boundary at Nogales, Ariz., whence its course is nearly due south to the Gulf of California, a distance of about 260 miles. This portion of the line has been in operation for a long time, and has been heretofore known as the Sonora Railroad. The gulf terminus of the Sonora railroad has been at Guaymas, a city with a population of about 12,000. Near Guaymas the railroad crosses an arm of the bay on a fill, a little over a mile in length, and then skirts the shore line for a distance of about 4 miles to the city. Therefore, when the new line to the south, formerly known as the Cananea, Yaqui River and Pacific R. R., was begun, the junction was placed upon the east side of the bay, and a new town, Empalme, was established at this point.

From Empalme the main line extends southeasterly, traversing the coastal plain between the Sierra Madre Mountains and the Gulf of California. At Corral the railroad crosses the Yaqui River and from that point a branch line extends northerly, along the river valley, opening to settlement a region rich in both agricultural and mineral possibilities. At Navajoa another branch line from Alamos joins the main line. At San Blas the main line crosses a portion of the Kansas City, Mexico and Orient Railroad, extending from San Pedro on the east to Topolobampo on the gulf. At Culiacan another short line is crossed, which extends from Culiacan to Altata on the coast. About half way between Culiacan and Mazatlan the main line again touches the coast and from that point to Mazatlan the right-of-way is so close to the ocean that the traveler is within sight of the surf, nearly all of the time. Mazatlan is the last port which the railroad touches. From that point the line leaves the ocean and passes through an exceedingly fertile country to the mountains which separate the City of Guadalajara and the coastal plains. The line across the mountains is an exceedingly difficult piece of construction and is not yet completed.

Upon the northern side of the international boundary two lines connect Nogales with the main line of the Southern Pacific Railroad in the United States. One branch extends from Benson to Nogales and has been in operation for a long time in connection with the Sonora Railroad. The other branch is a new short line from Tucson to Nogales which has just been constructed. The last of the track for this branch was laid April 21, 1910, and the formal opening of the new line was celebrated by the City of Tucson, on May 5 and 6, although the work of ballasting and surfacing the tracks is not yet completed. The fifth of May was considered to be a suitable time for this celebration since this is the Mexican Independence Day.

Through Pullman car service from Los Angeles to Mazatlan, via Benson, has been in operation for over a year, and since that time the service has been gradually extended, so that the road is now in operation as far as the Santiago River, 180 miles south of Mazatlan. From Guadalajara, passenger service is in operation as far as Tequila, 45 miles, for about one-half of which distance trains run over the Mexican Central Railroad. There remains a gap of less than 150 miles to be placed in operation. On account of the difficult construction on this portion of the line it will very likely require two years to complete the main line.

The total length of the main line from the international boundary to Guadalajara will be 1,100 miles. In addition to this there will be approximately 600 miles of branch lines, nearly one-half of which distance is now in operation. The most important of the branch lines is the Yaqui River branch which will be nearly 400 miles long when completed.

The country traversed by the new line varies from a barren waste at the northern end to a luxuriant semi-tropical region near the southern end. From Nogales to Guaymas the line passes through a desert similar to that in Arizona and New Mexico, with some fertile valley lands. The most important town on this portion of the line is Hermosillo, the capital of the State of Sonora, a city which claims a population of 14,000. Hermosillo is situated in a fertile valley, surrounded by the mountains, the agricultural land being devoted chiefly to orange culture. In the surrounding mountains are located some of the largest mining camps in Sonora. The many mines throughout the state are indeed Sonora's principal asset.

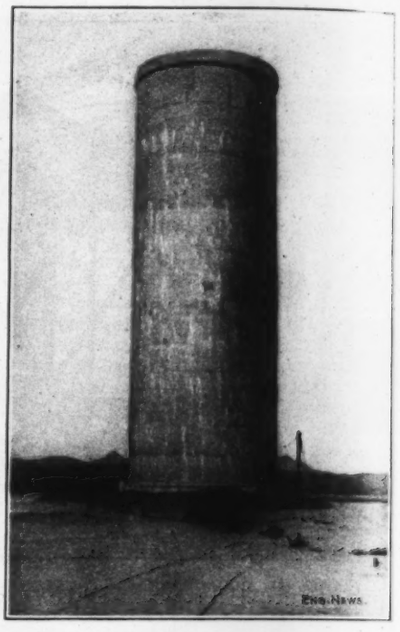


Fig. 3. View of Reinforced-Concrete Standpipe, Empalme, Mex., Showing Effect of Efflorescence.

Southeast from Empalme the railroad enters a region with better soil and somewhat more abundant water, but still retaining many characteristics of the desert. The mesquite continues to be the predominant bush but the quantity of vegetation increases. Along the Yaqui River are large tracts of land which have been purchased by American capital and are being developed as irrigation projects. This land is being sold to settlers at about $15 gold per acre, including water rights. Further along the line the vegetation continues to change in character, until near Mazatlan, which is almost exactly upon the Tropic of Cancer, the vegetation is a nearly impenetrable jungle. As far south as Culiacan, at which place there is a considerable American colony, irrigation is necessary for the production of crops, but from Mazatlan south no irrigation is necessary. The lands in the latter vicinity are known as humid lands and are capable of retaining sufficient moisture

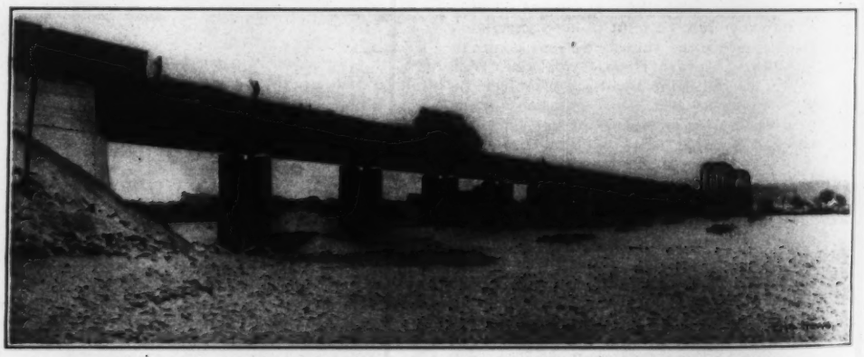


FIG. 2. BRIDGE AT CULIACAN, MEXICO, ON THE SOUTHERN PACIFIC OF MEXICO R. R.

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for vegetation for a considerable time. Furthermore, this region is subjected to heavy dews which materially assist vegetation during the dry season. This productive region has long been divided into large haciendas or estates, but many of these have already been purchased by American capital, and probably more would have been purchased except for difficulty of securing a satisfactory title.

At present the two principal ports along the line are Guaymas and Mazatlan. Of these Mazatlan has the better general location, since coastwise trade, which is bound to Pacific ports of the United States from Guaymas, is obliged to go nearly to Mazatlan to get out of the Gulf of California. However, Guaymas is blessed with a much better natural harbor than Mazatlan. The bay at this place is almost entirely surrounded, making a harbor of refuge which is protected from the rough water of the ocean. At present the inner harbor is too shallow for large boats, but it is claimed that there is from 6 to 7 ft. of slime on the bottom which could be removed with comparative ease, making an excellent harbor for all classes of shipping. The City of Mazatlan is situated upon a promontory which projects into the ocean, making a beautiful scenic location for the city but not furnishing natural protection for its water front. Furthermore, nearly all of the cargoes must be brought to shore by lighters.

The line of the railroad, being parallel to the coast, intersects all of the drainage from the western slope of the Sierra Madre Mountains, which makes necessary a large amount of bridging. There will be 25 river crossings of considerable size, for the most of which plate girder viaducts are being used. Among the important bridges are the bridge across the Culiacan River, consisting of 14 spans of 70-ft. deck plate girders and two 200-ft. spans of through Pratt trusses; the bridge across the San Lorenzo River, consisting of 32 spans of 70-ft. deck plate girders; the bridge across the Piaxta River, consisting of 16 spans of 80-ft. deck plate girders; the bridge at Rosario, consisting of 21 spans of 70-ft. deck plate girders; and the bridge across the Santiago River, consisting of 6 spans of 70-ft. through plate girders and three 200-ft. spans of through Pratt trusses. Fig. 2 shows the bridge across the Culiacan River and illustrates the general type of construction which is being used, and also the nature of the country traversed.

FIG. 4. TYPICAL RESIDENCE BUILT IN THE NEW RAILROAD TOWN OF EMPALME, MEX.

The principal shops for the railroad are located at Empalme. This is still in swaddling clothes, and as yet has no business district so that most of the trading is done at Guaymas. Between the two places the railroad operates a frequent and very good service with gasoline motor cars. The accompanying plan (Fig. 5) shows the plan of the townsite and the shops at Empalme. A view of some of the houses which have been erected by the railroad company for the heads of departments is shown in Fig. 4. For the other employees neat and comfortable frame cottages have been constructed. There is also a club house, which is a large two-story building with a screened porch around the entire second story and an open porch below. This building has 62 bed rooms, providing accommodations for the bachelor employees. Upon the first floor there is a lounging room, a billiard room, a well-supplied library, and a dining room. At the center of the town is a plaza, the centre of which is occupied by a reinforced-concrete stand-pipe, 30 ft. in diameter and 90 ft. high. A brief description of this stand-pipe was given in Engineering News, Dec. 9, 1909, p. 635. The view (Fig. 3), shows the stand-pipe, upon which can be seen the efflorescence which had occurred by the time it ceased to sweat. This efflorescence is flaky and could easily be removed by scraping. The appearance of the tank could be very much improved by thus removing the efflorescence and by giving the structure a brush coat of neat cement or a coat of wall finish. The water-supply for Empalme is obtained about 2½ miles east of the town, from four wells 10 ins. in diameter and 800 ft. deep.

Empalme has a system of sanitary sewers, the sewage passing through a septic tank before emptying into the bay. The ground upon which the townsite is located is so nearly level that the sewers have very low gradients, some of the grades being as low as 0.08%. The outlet from the septic tank is below extreme high tide, making it necessary to provide a storage tank in addition to the septic tank. When the tide rises it closes a flap valve at the outlet to the septic tank, causing the effluent to pass into the storage tank. When the tide falls the contents of the storage tank and also the effluent from the septic tank are discharged into the bay.

The shop buildings present an imposing appearance, and indeed they are very substantial and serviceable buildings. The round house is the building which was first erected, and is con-

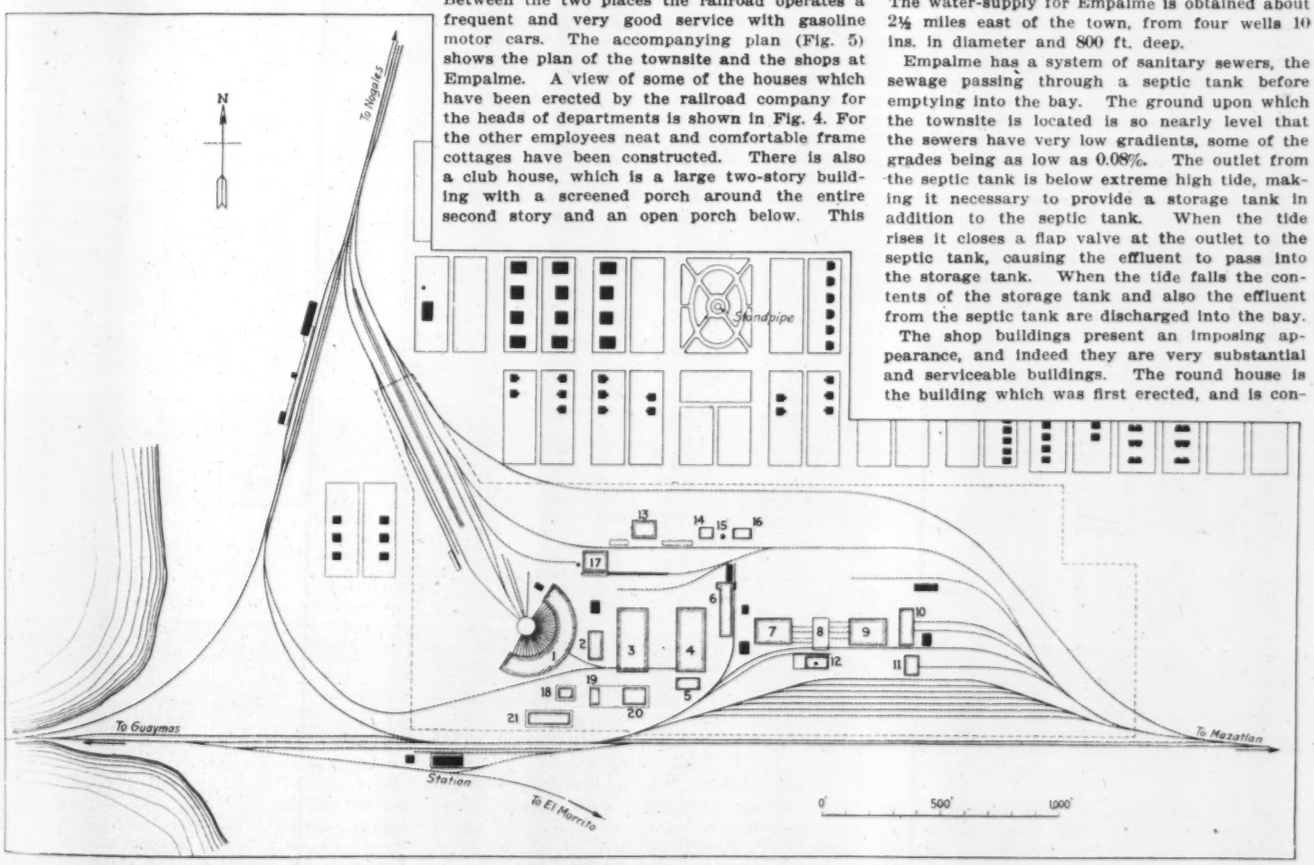


FIG. 5. MAP OF TOWN OF EMPALME, SHOWING LAYOUT OF SHOPS AND STREETS.

1. Round House.
2. Copper, Pipe, Carpenter and Electrical Shop.
3. Machine and Erecting Shop.
4. Boiler and Blacksmith Shop.
5. Tube Shop.
6. Material Shed.
7. Paint Shop.
8. Transfer Table.
9. Car Repair Shop.
10. Mill.
11. Steel-Car Repair Shop.
12. Car Repair Store House.
13. Foundry.
14. Pattern Storage.
15. Emergency Hospital.
16. Shop Office.
17. Power-House.
18. Oil House.
19. Stationery Store House.
20. Store House.
21. Warehouse.

structed of local stone. The principal buildings which were subsequently erected are of concrete and steel construction, although some of the last and some of the less important buildings are of wood frame construction with corrugated iron exteriors. Most of the buildings of concrete and steel construction have concrete walls with steel roof trusses, but the largest building, the machine and erecting shop, has a complete steel skeleton with concrete curtain walls. The bay which is used as the erecting shop is commanded by a 100-ton crane, which is the sole means of transferring the locomotives from the entering track to the other portions of the shop. Most of the machines throughout the shops are driven by direct-current motors, the current for which is supplied by two 200-KW. direct-current generators. The chimney for the power house is a reinforced-concrete stack, 138 ft. high, with a uniform outside diameter of 9 ft. 11 ins.

For information and other favors the writer is indebted to Mr. P. J. Archer, formerly Chief Clerk to President Randolph, to Mr. E. J. Gass, Engineer of Bridges and Buildings, to Mr. R. W. Patterson, Assistant Engineer at Empalme, to Mr. G. A. Gow, of Empalme, and to many others.

A Coal and Ash Handling Plant (with Underground Transportation System).

The mechanical handling of coal and ashes at office and other large buildings in large cities requires machinery which is efficient in itself, which requires but a small amount of power and attention, and which can be installed in limited space. These conditions form a special problem in nearly every case, and an example of an installation of this class is that in the boiler room of the Merchants' Loan & Trust Building, on the corner of Adams and Clark Sts., Chicago. In most large cities, the delivery of coal and the removal of ashes has to be done by wagons, but in Chicago it is done to a very large extent by the system of the Illinois Tunnel Co., which has some 60 miles of deep level tunnels (with a narrow gage electric railway) forming a network serving practically every street in the business district and extending into the outlying districts where freight yards, coal yards and industrial plants are located. This not only facilitates the work, but relieves the street traffic from the slow-moving wagons with their dirt and dust. The tunnel company handles freight, parcels, newspapers, etc., as well as coal and ashes, but the latter form an important part of its business.

The building referred to is a large office building of the modern type, and has in its basement a boiler plant for supplying hot water, heating the building and serving three restaurants. There are four hand-fired 100-HP. boilers, three of which are in use all the time, with the extra one for the increased demand in the winter. The fuel consumption is about 20 tons per day. The fuel used is No. 5 washed coal, and contains a considerable amount of moisture. It is delivered in the 3½-ton steel cars of the tunnel line, which are loaded at a railway coal yard at 14th St. and run to a siding (underground) near the building. At some convenient time, usually in the afternoon, a train of cars is hauled into the Adams St. branch of the tunnel, the cars being dumped by the brakemen. The ashes are delivered to the cars when there is a sufficient accumulation in the boiler room.

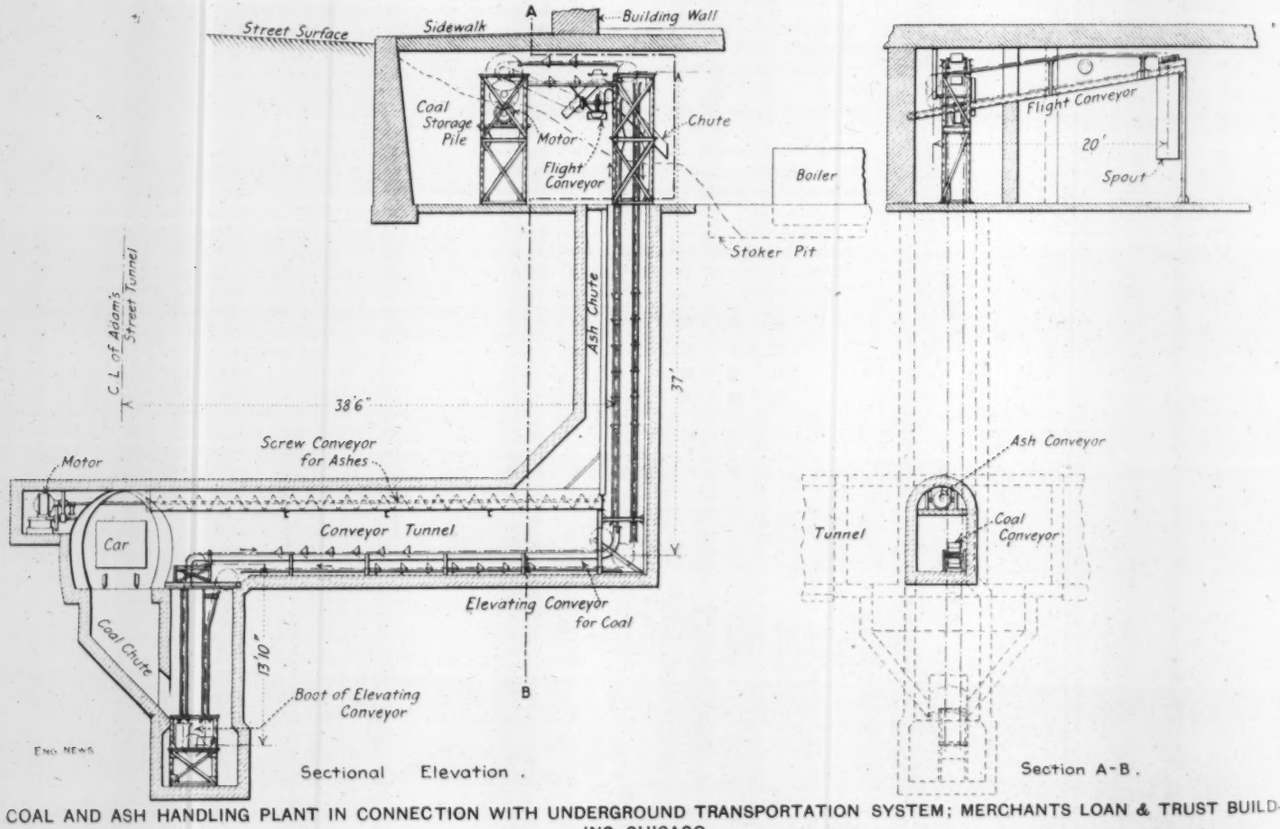
The arrangement of the machinery for handling the coal and ashes is shown in the accompanying cut. Each car is halted over a concrete pit or hopper under the track, and the load is dumped, the coal being delivered by a chute into the boot of an elevating conveyor consisting of two endless chains carrying V-shaped buckets 2 ft. apart. It will be seen that the conveyor has both a vertical and a horizontal travel. In the latter case, the buckets act as flights and push the coal along in a steel trough; at the change in direction to vertical travel they adjust themselves automatically and lift the coal as in a bucket elevator. The machine first lifts the coal 12 ft. to the level of the conveyor tunnel level, and then conveys it horizontally for 30 ft. to the shaft where it is lifted 35 ft. to the boiler room. The conveyor here has a horizontal travel again to reach the driving sprocket, and in making the turn the buckets discharge the coal into the trough of a transverse flight conveyor running at right angles to and in front of the boilers.

This conveyor sprocket consists of a single endless strand of chain, which runs over two sprockets, 20 ft. apart, mounted on a steel frame. Fastened to the chain are steel flights, 2 ft. apart, which (on the lower run) push the coal along in a trough formed by riveting a steel plate to and across the flanges of the two supporting channels. The coal is discharged through an opening in the trough into spouts which deliver it (at either side of the trough) upon the storage pile in front of the boilers.

The ashes are shoveled onto a grate through which they pass into a concrete chute which discharges into a special 16-in. cast-iron screw conveyor, which conveys the material to the tunnel. At the tunnel end of this conveyor is a sliding steel trough which may be run out directly over the tunnel cars.

The gravity discharge elevating conveyor and the flight conveyor are both driven through two gear trains by a 10-HP. electric motor, which is fitted with a rawhide pinion to eliminate noise. The screw conveyor has a 5-HP. motor located in a chamber at the tunnel, as shown. The equipment is capable of handling 40 tons of coal per hour, and was designed and built by the Stephens-Adamson Mfg. Co., of Aurora, Ill.

The present boiler equipment necessitates firing by hand, and hence the storage pile arrangement as shown in the cut. At some future time, however, new boilers with automatic stokers may be installed and the same conveying system can be adapted very readily to this new arrangement. In this case, the short flight conveyor will be removed and the elevating conveyor will be extended upward and over the boilers where it will discharge into a 200-ton storage hopper. Thence it will pass down and under the boilers, where it will receive the ashes and convey them to the grate above the concrete ash chute. The single equipment will then deliver the coal and haul away the ashes, and will do away with all manual labor.



COAL AND ASH HANDLING PLANT IN CONNECTION WITH UNDERGROUND TRANSPORTATION SYSTEM; MERCHANTS LOAN & TRUST BUILDING, CHICAGO.

(Stephens-Adamson Mfg. Co., Chicago; Builders.)

Standardizing Public-Works Contracts.*

By R. WALTER CREUZBAUR.†

We of the municipal service must all realize to a greater or less degree the importance of the cooperation and interchange of ideas derived from the handling of public contracts and affairs. An ideal condition is more closely approached when the administrative and financial officer and the engineer, guided by the legal officer, try to agree on what is best in standardizing contracts for great and small public works.

Defective Contracts Produce Litigation.

At the time of consolidation (in 1898) the engineering questions in the five boroughs of New York City came under the direction of the writer only so far as street improvements were concerned, and, while an attempt was made to standardize such contract forms and specifications, and a number of changes were put into effect and are in effect to-day, the work was interrupted. In a new field of observation, the Department of Finance, a few months later a magnificent object lesson in variegated and objectionable forms of contracts and specifications was brought before me in an assignment to examine improvements and make engineering audit and adjustment of thousands of contract vouchers and claims directed against the city treasury. I believe there were more than eighty municipalities and controlling boards consolidated at that time. In the two larger boroughs especially a great variety of such forms, carrying indeterminate and ambiguous provisions, brought about difficulties and subsequent litigation through resistance to payment interposed by the financial officer of the city.

Litigation of claims amounting to many millions of dollars has since been caused through the lack of standardization of New York City contracts, and the city is losing cases continually. The remedy, while so apparent, is not being applied to any extent; and in the great departments and special boards of the city very much is to be desired in a clear determination of legal and engineering terms and absolute definition of the city's and the contractor's liability.

Essentials of a Public-Works Contract.

Looking at the broad proposition in which we are interested, we can I believe safely assume that a sane and safe contract should provide:

1. That a clear definition of all work and materials to be furnished by the bidder be carried consistently throughout the invitation to bidders, the form of contract, the bond and the contractor's proposal, all of which must agree in their general terms with the specific and detailed description of the specifications. Under this head we should also urge brevity and no repetition, except where the lawyers insist on repetitions in the legal forms.

2. That these definitions and descriptions of work and materials must provide in a unit-price contract a clear distinction between (a) all such items of work and materials which are to be paid for as classified under unit item bids; and (b) such uncertain and contingent work of miscellaneous nature as is to be supplied by the bidder without direct compensation, being carried or floated over the other item prices. To illustrate, sheeting and excavation in a sewer trench where a price is taken only for a sewer complete per lineal foot, including all incidentals, is in class (b), items not directly bid for.

3. That provision be made by which extra work, unknown as to character or extent at the time a contract is made, may be ordered and paid for under such stipulations and reasonable control as may be just to both parties. This applies especially to public works of magnitude, where subsurface conditions and extent of foundation have not been fully exploited. In street work, or work of a simple character the provision for such extras may be omitted.

4. That the contract should embody a clearly expressed provision for a uniform and fair valuation of all classes of work and materials to be paid for in partial or monthly payments, so as to protect the city from unbalanced bids and the necessity for financing a contractor to an unfair extent during the progress of the work where he has so adjusted his bid as to call for a large allowance on the first items of work to be done.

5. That a determination of the most favorable bid cannot be made in a unit-price contract by taking only the gross sum without comparison of the prices of all the items, and figuring interest thereon, as compared with the interest to be carried by the City on the monthly allowances called for by payments on a balanced bid. In public works of magnitude, extending over several years, this question of the extent to which the city shall finance contractors is of great importance.

6. That, aside from this feature, unbalanced bids may operate to the disadvantage of the city in the event of variation in quantities anticipated and given in the engineer's preliminary estimate. The basis for this axiom in the City of New York may perhaps be given in the case of Nelson vs. The Mayor, where unbalanced bids and subsequent increases in quantities bid for at high prices and omissions in quantities bid for at low prices constituted in the decision of the courts sufficient evidence of collusion and rendered the contract void.

7. That where alternate methods of construction or substitution of materials are allowed under the contract, and where only one price has been established for each general classification of such work and material, the option in every case for the selection of the satisfactory alternate method of construction or character of material to be substituted, must be vested directly with the bidder, not only in the interest of economy, as better competition is so invited, but because otherwise we have "a specification which does not specify," affording a broad opportunity for the annulment of the contract by a taxpayer's action, as in the well-known bridge case of Gage vs. The Mayor, City of New York.

"Additional" Work and "Extra" Work.

As financial officers of great cities and institutions, your association may be especially interested in an administration bill recently approved by the Board of Estimate as a step toward some of the ideal conditions which I have crudely summarized under these seven headings.

This administration bill, revising the charter, provides that in every contract there may be inserted a provision defining what is "additional" work and what is "extra" work, questions which have led to much confusion throughout the city. The difference between these terms is defined by stating that the work, performed under a contract based upon estimated quantities and payable at unit-prices, in excess of such estimated quantities shall be deemed *additional* work; and that work done in connection with a contract and not specifically covered thereby, which is not additional work as herein defined, shall be deemed *extra* work.

To meet extreme conditions under the old form of bidding the bill provides that if additional work be required for completing the contract to an extent in excess of 5% as provided of the estimated quantity of said item bid upon, or should extra work be required for the completing of the contract, the work in question may be done under a supplemental contract entered into without public letting by the Board of Estimate and Apportionment acting on behalf of the city, after the receipt and filing of an itemized report from the head of the department stating the reasons therefor and the estimated costs thereof.

"Additional" Work Under Percentage Unit Bidding.

The bill also provides a standard of procedure in the use of Percentage Unit Bidding, presented by the writer to the Board of Estimate in 1905 but subsequently used only in the Borough of Brooklyn. This provision reads as follows:

> In contracts for work and materials, however, where bids are invited according to the percentage unit bid plan where the borough president or head of department has established a fair and reasonable unit value for each class of work and materials required and the contractor has bid a certain single percentage applying to all such unit items of the contract, and provided that such additional work and materials be actually required to properly complete the general work specified and that such work be ordered in advance in writing by the borough president or head of department and a copy of said order be immediately filed with the comptroller of the City of New York, the work and materials may be increased.

I invite your attention to this plan of bidding, which is largely used abroad, as an excellent plan where the engineer is able to balance values for the unit items advertised; as a specialist on the work it is believed that he can generally balance these values and certainly can be trusted to do so better than the average bidder for city works.

Financing the Contractor.

Even under an ideal condition, when no variation in quantities is shown in the final certificate of acceptance issued by the engineer, Percentage Unit Bidding has this important function: It has served to definitely establish in advance of the receipt of proposals a basis on which the contractor is to be financed by the city during the progress of construction, because the engineer's estimate, both of quantity and unit value, has been known and published as the 100% basis on which the single percentage submitted by each bidder is applied throughout the progress payments and on final acceptance of the work. Furthermore, in the event of a variation in quantities, as in change of foundations and increase or decrease in quantities of shoring and bracing of a trench, or for many other reasons constantly causing changes in quantities, both the city and the contractor are protected to the extent of the engineer's ability to apportion his profit uniformly over the items which may have been varied as to quantity up to the time of the completion of the works.

The bill also provides that interest at the rate of 4½% shall be paid on any estimate properly verified and recorded in the Department of Finance more than thirty days, and that on large assessable improvement contracts exceeding a quarter of a million dollars, the contractor may receive 90% of the amount earned, instead of only 70%, after such time as the retained percentage equals $75,000. It is hoped that these provisions of the administration bill may soon be incorporated in all important departmental city contracts, and that the strong trend toward standardization will extend also to the great commissions and boards of the City of New York, where the works about to be undertaken will amount to several hundred millions of dollars.

Money Losses Due to Defective Contracts.

And speaking even more informally, I would say that nothing illustrates plentitude in the popular mind better than the full barrel. The American city as a rule has a full treasury barrel. The financial officer may be at the controlling faucet, directed when to open and shut off by the character, by the legal officer and the engineer; but the time-worn barrel, filled by the annual increment of millions from taxation, is leaking at many seams. Much caulking of these leaks can be done by the legal and engineering experts if they could be made to work intelligently together until the treasury be safeguarded against legal and engineering leaks and open opportunity for those infrequent frauds which occur. Most costly to the city, however, are the leaks due to inefficiency and lack of cooperation of city officials entrusted with the task of laying out public works and preparing these forms of contracts and specifications, and the efficiency of the financial officer would be greatly increased and his duties simplified and litigation avoided if proper contracts only were advertised, telling the bidders exactly what they were to do, providing clear means for getting it done, and for paying promptly for it when it is done.

The legal officer and the engineer should work together, and I do not think that they should use the scissors on the old forms and patch up new contracts for new sorts of work. They should approach this thing and go into exactly what is to be done and describe clearly, concisely and very carefully all the points.

Now, on the one point of abandoned asphalt maintenance in New York City, the trouble is that in the old form of contract (also in use to-day), the contractor was required to make repairs within forty-eight hours of the service of a certain notice by the head of the department stating that such asphalt pavement surfaces were worn and defective. Now, just a change of a few words would have put the burden of continual maintenance squarely on the contractors, where it belonged in all honor and fairness, and the city would not be put to the trouble of showing why the notices were not served in all cases. I have detailed knowledge of very many cases where the city has been trimmed in the aggregate millions of dollars both through the looseness of the contract forms and the laxity of interpretation of the contracts.

The Corporation Counsel has also given the authorities many kinds of opinions based on the same form of contract, and I speak knowingly and of specific cases. In one case he has told a department to go on with additional work, to the amount of a 30% increase over the contract amount, where he has been told that the price for this particular item of the work was 2½ times what it was worth; in another case, on precisely the same form of contract, the department had stated that, while the price was one-third too high, the work was imperative and was already done, but the Corporation Counsel determined that the work could not be paid for and that the contractor must sue. We have accumulated a remarkable assortment of opinions of the Corporation Counsel showing such vagaries of the legal mind. The debits of the city written off on such account have been enormous, and these incompetent opinions should be charged up to the individuals who wrote them. Right here in New York we should hereafter be able to stop these great leaks in the city treasury by a competent analyses of city contract forms by able corporation lawyers and experienced engineer officers of the city, and standardize all legal and engineering terms, and be hereafter able to successfully resist a very great proportion of contract litigation as now attempted against the city, and proceed with the municipal business on a carefully established and rational basis throughout.

The "approval as to form" of New York City contracts required by the charter, as given for many years, has been a farce, and the interpretation of the contracts most confusing. It would seem that the authorities of other cities might take a lesson and standardize the working forces as a first step toward standardizing the contracts.

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*Slightly condensed from a paper, "The Necessity for Standardizing Contracts of the City of New York," read before the National Association of Comptrollers and Accounting Officers, June 10, 1910.

†Consulting Engineer of Public Works, Borough of Brooklyn, New York City.

THE FOREIGN COMMERCE of the United States totalled about three and one-quarter billion dollars for the fiscal year ending June 30, 1910. Of this exports accounted for one and three-quarter billion, and imports, one and one-half billion in round numbers. The excess of exports over imports was the smallest for any year since 1896. The heavy reduction was "due to a falling off in the exportation of food stuffs and an increase in the importation of manufacturers' materials."

Reinforced-Concrete Barges on the Panama Canal.

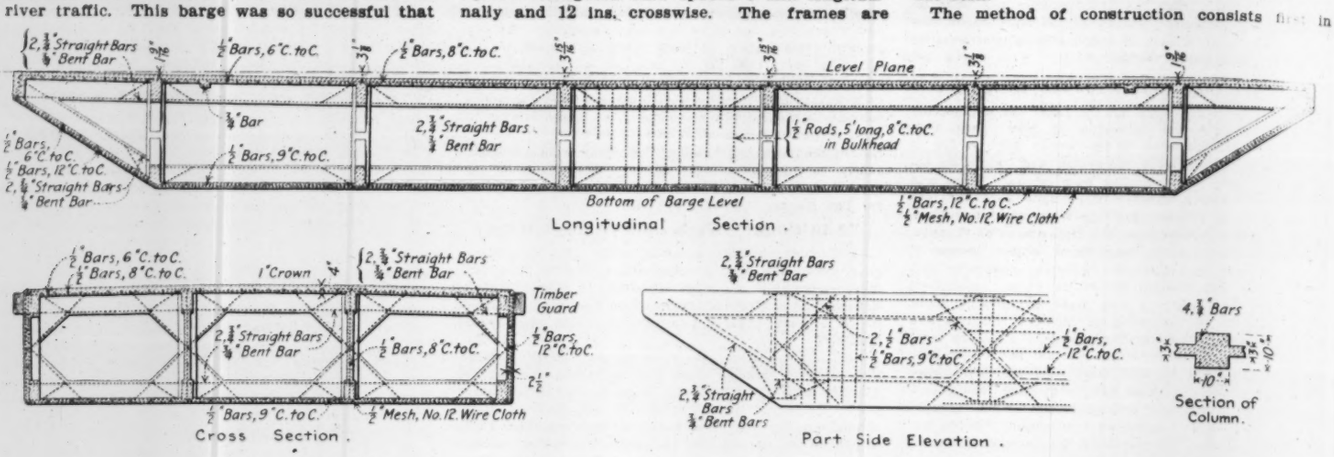
Some years ago an Italian contracting firm designed and built for use on the Tiber a reinforced-concrete barge of the same general type as those generally made of wood or of steel and used in river traffic. This barge was so successful that the firm immediately commenced the manufacture of similar barges and a number have been put in use on the rivers of Italy. A short time afterwards it was announced that a firm on the Missouri River in this country was prepared to build such barges but, so far as we know, this work has not progressed beyond the experimental stage, nor have any other such boats, of full-size at least, been built in this country. The reinforced-concrete barges described in this article, built by the Isthmian Canal Commission for use at Panama are then the first large size vessels of this type that have been built on this continent, and their design and construction should therefore be interesting.

Approximately 8,000,000 cu. yds. of material are to be excavated by hydraulic methods from the canal prism on the Pacific division of the Panama Canal. Hydraulic monitors will be employed to disintegrate and wash the material to centrifugal dredging pumps and the latter will lift and distribute it, through sluices, over the adjacent tidal swamps, thus reclaiming about 450 acres of land. The dredging pumps will have to be moved from time to time. Under the existing conditions, a floating support of light draft is the most economical, and reinforced-concrete barges were selected for this purpose as they may be built at a cost very much less than for steel and only slightly in excess of wooden barges, while the maintenance cost is practically nothing.

The barges are the well known flat-bottom type, extensively used on the rivers in the United States, with a rake at both ends. The details of one of the barges is shown in Fig. 1. The over all dimensions are 64 × 24 ft. and the hull is divided into three compartments by longitudinal bulkheads spaced 8 ft. c. to c. The gunwales, bulkheads and bottom are tied together and stiffened by lateral frames at intervals of 10 ft. The deck has a sheer of 4 ins., and is crowned 1 in. The gunwales and bottom are reinforced with ½-in. mesh, No. 12 wire cloth, attached to ½-in. square corrugated bars spaced 9 ins. longitudinally and 12 ins. crosswise. The frames are knee-braced and reinforced as shown in the figure, and the deck is reinforced as an ordinary floor slab with rods in both directions.

Six manholes 21 ins. in diameter are provided for inspection, in the locations shown on the drawing, and alongside of each line of these an extra transverse beam of shallow depth is placed. Mooring bitts are also provided as shown in Fig. 1. For the protection of this barge large timber fenders are to be fastened along the sides near the deck.

The method of construction consists first in



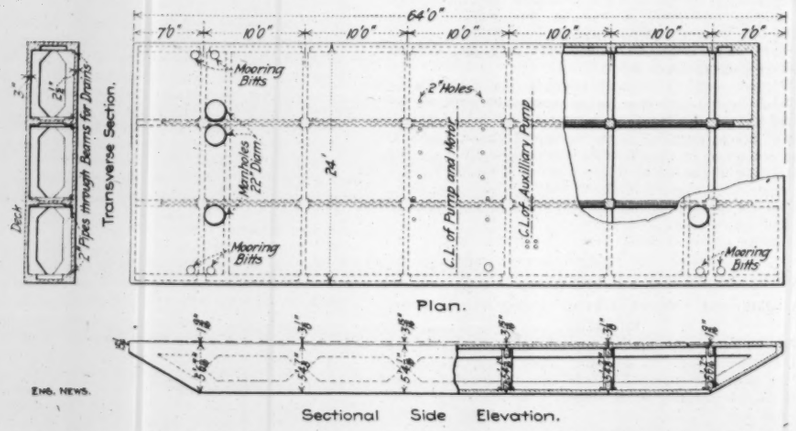


FIG. 1. DETAILS OF REINFORCED-CONCRETE BARGE FOR USE ON THE PANAMA CANAL.

placing the wire cloth reinforcement of the bottom, sides and rakes on cribbing of sufficient height and so arranged as to permit working underneath the bottom. The rods, previously bent to the proper shape, are then securely wired to the mesh. This forms a skeleton of the barge and the whole is plastered with a 1:2 cement mortar to which has been added 25% of lime. The plaster is laid on the outside of the wire mesh in two coats aggregating about ½ in. in thickness; the inside is then plastered thick enough to cover the reinforcing rods, the result being a slab having a total thickness of about 2½ ins. The plaster is rubbed down to a hard, smooth surface, especially on the outside. Upon the completion of the shell the reinforcement and forms are placed for the bulkheads and cross frames, the reinforcement being securely attached to the shell by wires and ¼-in. hooked rods previously inserted in the latter for this purpose. The frames and bulkheads are then filled with a 1:2:4 concrete to the bottom of the deck slab and, finally, the latter is placed in the usual manner of laying a concrete floor and given a trowel finish. The forms

FIG. 2. INTERIOR OF BARGE DURING CONSTRUCTION SHOWING REINFORCEMENT OF RAKE, TRANSVERSE BOTTOM BEAMS AND GUNWALES.

for the deck, interior bulkheads and frames are constructed so as to be removed and used over again. Figs. 2-3 shows the skeleton with the plastering and concreting partially completed.

The first barge was launched on April 20, 1910, 12 days after completion. It is shown in Fig. 4 in the water, with No. 2 under construction on shore. Before barge No. 1 was launched, five or six cracks appeared on the bottom and one in the gunwale. Several of these seemed to extend entirely through the slab, and leaked slightly when tested by partly filling the barge with water. The cracks were cut out and replastered and no leaks have developed during the six weeks that the barge has been in the water.

FIG. 3. PLACING CONCRETE IN INTERIOR OF REINFORCED-CONCRETE BARGES.

The weight of the concrete, including the plaster, was assumed at 150 lbs. per cu. ft., and the actual weight of the steel taken, for computing the theoretical displacement. The dead load was computed to be about 230,000 lbs. which would give a displacement of 2 ft. 9 ins., but the draft of the first barge is greater than computed by slightly over three inches. The reason has not been ascertained as yet, but careful records are being kept of the dimensions and material used in the second barge in order to secure more accurate data for computing the displacement.

These barges are being built for the specific purpose of supporting the dredging pumps, necessary motors, etc., and it is believed that for purely commercial or transportation purposes the designs may be modified so as to lighten them materially.

Designs are now being prepared in the Pacific Division of the Canal for reinforced-concrete dump-scows, with the idea that they will be the most economical type for service not only during construction, but for maintenance after the canal is completed.

The above information was furnished us through Lt.-Col. Goethals, by Mr. S. B. Williamson, Division Engineer, Pacific Division, under whose supervision the design and construction of the barge was carried out.

Modern Methods of Street Cleaning.*

By GEORGE A. SOPER, Ph. D., M. Am. Soc. C. E.†

The work of cleaning city streets is at once the oldest and least developed branch of municipal sanitation. In the whole work of making cities habitable, there is no undertaking which affects comfort more certainly or with whose results there is such universal dissatisfaction. Judged by the requirements of the case, it must be admitted that most cities are very dirty. If some appear to be clean, they seem so by contrast to other and still dirtier places.

Concerning the correct principles of scavenging, little is generally known. Although every citizen is a competent critic of the results, few are willing to make a sufficient study of the problem to understand its difficulties, much less devise the practical measures of improvement required.

COST AND PRINCIPLES OF ADMINISTRATION.—Efficiency in operation is less in scavenging than in most other sanitary undertakings, but with time it may be increased. A constant effort should be made to improve upon the methods employed, to keep accurate account of the ways in which the money is spent and to accomplish the results which the citizens expect. A system of scientific scavenging carried on according to this principle deserves adequate financial support and, with proper management, sufficient money can usually be obtained for it.

In seeking appropriations, mistake is often made in asking help of politicians. Political influence is nowhere more pernicious than in the operations of a street cleaning department. For every favor conferred, a political boss requires a suitable return, the result being that many street cleaning departments are to-day overburdened with men who cannot get a living except by pension. Occupants of prisons and poor houses should not be put to work to clean streets. The work is demoralizing to them and, what is more important, they are demoralizing to the work. The men should be young, strong and capable not only of doing a fair day's work, but of taking a personal interest and pride in it. There is no reason why a sweeper should not take as much pride in the cleanness of the pavement assigned him as a good sailor takes in the order of his ship. There is nothing disgraceful about scavenging except the inefficient manner in which it is sometimes done.

TECHNICAL CONSIDERATIONS.—Passing now to the technical side of street cleaning, we may consider very briefly a few of the central objects to be kept in mind. The chief business of a street cleaning authority should be to keep clean places clean, not to clean dirty places.

*Portions of an address delivered before the first New England Conference on Street Cleaning, Providence, R. I., June 29, 1910.

†Consulting Engineer, 47 Battery Place, New York.

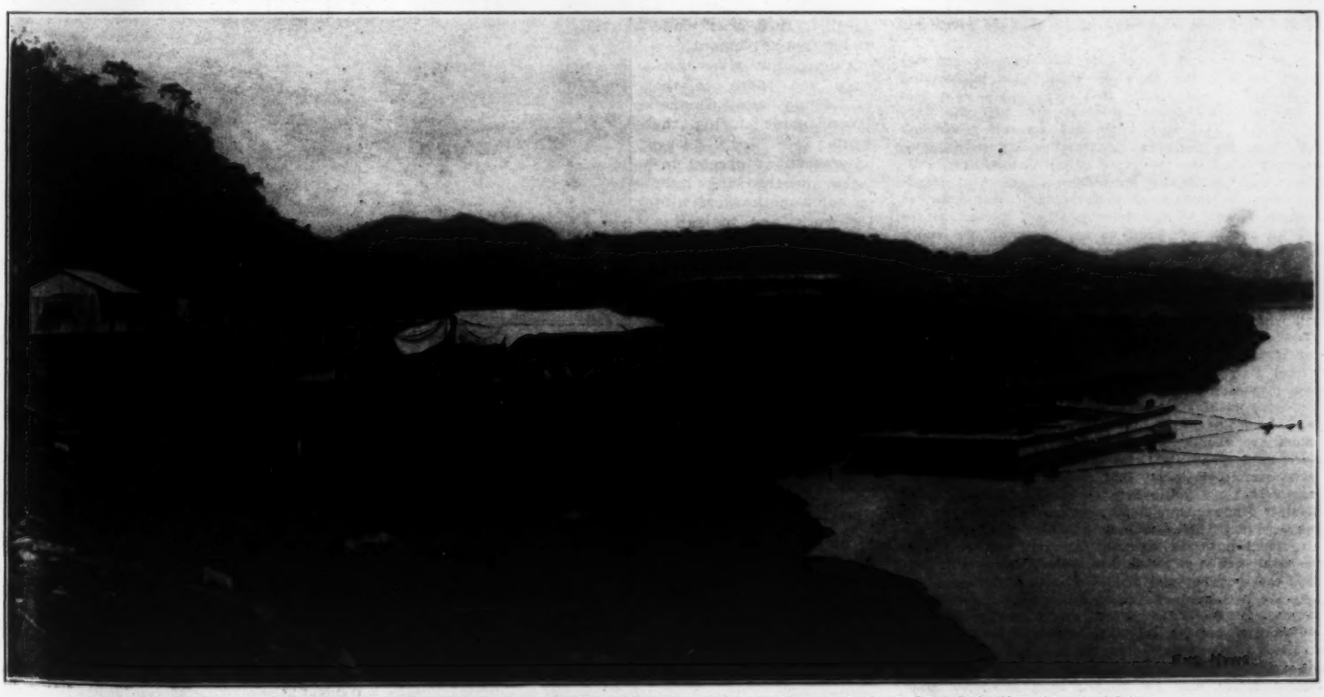


FIG. 4. VIEW OF ONE REINFORCED-CONCRETE BARGE IN THE WATER AND ONE BEING BUILT ON SHORE.

This maxim, originated by Colonel Waring, holds true for city streets and is a good policy to adopt in many other directions. Some dirty places will have to be cleaned, but neither the public scavenger nor the householders should permit refuse to litter streets or yards.

To keep a city clean it is essential that the scavenger should receive adequate cooperation from the public. No man, nor body of men, can maintain clean streets if the public does not wish them to be clean and is not willing to help keep them so. The scavenger should keep faith with the public by collecting the refuse according to an announced schedule. The receptacles should be handled with due regard to their destructibility and with proper respect to the convenience of the householder.

Whenever possible, the same authority should collect the wastes which is required to dispose of them. Proper disposition can only be made of wastes which are of the composition for which provision has been made at the disposal place, and the persons who do the collecting, and so come in contact with the householders, are alone able to see that the proper composition is maintained. Proper composition here refers to the three classes of ingredients into which household refuse is often divided: First, kitchen refuse; second, ashes, glass and metals, and third, readily inflammable matters, such as paper, wood and cloth. Sometimes the three are collected and disposed of in mixed condition, sometimes separately. Whatever system is adopted, it is important that that system should be adhered to by every householder. Choice of a system depends chiefly upon the method of final disposal best suited to the city.

APPARATUS AND METHODS OF COLLECTION.—As to the apparatus to be employed for collection, many details need to be considered when devising a system of scavenging which do not require to be discussed here, such as the proper size, form and material for the collecting carts, brooms, shovels and other apparatus.

The familiar rotary sweeper, known as the horse broom, is a standard apparatus, and is widely used in Europe and America, especially where there is much surface to be cleaned and the pavement is irregular. It should always be preceded by sprinkling carts and followed by men with hand brooms to sweep the throw of the rotary brooms into piles. These piles must be shoveled into carts and carried away as soon as possible, or the material which has been collected will soon become scattered again.

The so-called patrol system, by which men with an equipment of shovel, broom and receptacle mounted on some form of hand cart, patrol the streets to collect small masses of coarse refuse before it is broken up and scattered about is another procedure which may be termed standard.

Street flushing with water, with and without the aid of foot laborers provided with brooms, rubber squeegees, is a method of cleaning pavements which has claimed a large amount of attention in recent years. There is much to be said in favor of the cleanness possible with flushing, but good results without an extravagant waste of water, not to mention possible injury to pavements and sewers, are not so readily obtained as a casual observer might suppose. This kind of work calls for careful and intelligent labor, especially where the pavements are not good and smooth.

In America, as in Europe, inventors have devised machines to take the place of hand labor in cleaning streets and it would seem that there was a good field for the exercise of ingenuity in this direction. Machines successfully sweep and water and squeegee pavements and there are flushing machines and dust-collecting machines which are receiving strong endorsement. We should seek to employ all truly economical apparatus whenever the amount of work is sufficiently great to warrant the cost of it, but the merits of mechanical appliances should not blind us to the limitations which all machines possess. No machine can wholly take the place of intelligent hand labor. So far as my observation goes, the efficiency of any mechanical street cleaning apparatus depends largely upon the care and skill with which it is used.

The subject of machinery suggests the use of motors and here, too, there is a promising field for inventors. Several European cities use motors for propelling the carts necessary to remove household and street refuse, and street washing machines have been propelled in this way. According to my best information, the economy of motors over horses lies chiefly in running them long hours, as day and night, for example.

It is regrettable to say that a standard cart for street cleaning has not yet been agreed upon. Nothing more certainly shows the incompleteness with which the apparatus used in scavenging has been developed than this. Most carts are too high, too small and too heavy. The ideal cart is of metal, low-bodied, water-tight, covered, easy-running and light. The best European designs are far ahead of American practice.

FINAL DISPOSITION.—There are a number of ways to dispose of garbage and other household refuse after it is collected, all of which may be followed in a sanitary and satisfactory manner with proper attention to details.

Mixed refuse may be dumped upon low-lying land. This is usually considered an unsanitary proceeding, but if the dumps are well chosen the material leveled as rapidly as it is dumped and promptly covered with soil, there is little sanitary objection to it. To minimize the chance that foul odors will be produced the amount of kitchen refuse should be small.

The kitchen refuse may be dug into the ground. In this case it is desirable for reasons of economy that the putrescible elements should be put in separate receptacles at the household and collected independently from the rest. The putrescible material may then be dumped upon a field and plowed under. This method takes a large amount of land, but is sanitary and not unduly expensive where suitable ground can be obtained.

Kitchen waste, variously termed swill and garbage, can be utilized by feeding it to hogs. This method is very commonly employed by professional scavengers. It can be carried on in a sanitary manner and, although objections may be raised against it, these can be largely overcome.

Kitchen refuse can be turned into compost. Composting is commonly practiced in European cities. Every farmer composts stable refuse when he makes manure. It is essentially a rotting process. The garbage to be composted is piled in heaps about 3 ft. high, from 6 to 10 ft. wide and about 30 ft. long. It is thoroughly wetted and allowed time to rot. Eventually the piles are opened up and the material employed as fertilizer. Garbage composts should be located as far as practicable from houses and highroads. [Mention was also made of incineration and reduction—Ed.]

In none of the foregoing methods of finally disposing of household refuse is there any prospect of profit. Methods of disposal which promise a return are generally misleading and foredoomed. The object to be kept constantly in mind in this connection is to have the material disposed of promptly, thoroughly, finally and with as little offense as possible. The question of economy or return from the utilization of municipal wastes should be a secondary consideration. At the present stage of sanitary science, it is impracticable to secure a substantial return from the disposal of municipal wastes.

Methods and Costs of Midwinter Surveying; The St. Louis and Cloquet River Surveys, Minnesota.

By C. R. ADAMS,* Assoc. M. Am. Soc. C. E.

The U. S. Geological Survey, acting under a cooperative agreement with the state of Minnesota, has been making an investigation of the water resources of Minnesota. This investigation has comprised studies of the flow of various rivers, and surveys of rivers and lakes for power and storage purposes. The survey of Mille Lac Lake, which was described in Engineering News of April 7, 1910, was made under this agreement.

Among the river surveys are those of the St. Louis and Cloquet rivers made during the winter of 1910. These have been of special interest in throwing light on some methods of winter work, and indicating something of the value of transit stadia leveling. The making of the surveys of these two rivers during the winter season was to a certain extent in the nature of an experiment. The feeling was, at the time of commencing work, that ability to get around on the ice would in a large measure offset the disadvantages of cold and snow. Results have shown that the cost of surveying under these winter conditions, did not vary much from that of work of the same class done during the summer months.

The St. Louis and Cloquet rivers both lie in St. Louis county in northeastern Minnesota. They rise but a few miles apart and follow an approximately parallel course, traversing a wooded and largely unsettled region until they unite near the small town of Brookston, and finally flow into Lake Superior, near Duluth.

Plan of Survey.

Surveying was commenced at Scanlon on the St. Louis River, some 20 miles below Brookston, and continued up that river to Skibo on the Duluth & Iron Range R. R., a distance of 155.7 miles. At the end of the St. Louis River survey a line of wye levels was carried from the last station on the St. Louis River survey to the initial point of the Cloquet River survey, a distance of 15.9 miles. The Cloquet River survey was then commenced at Brimson on the Duluth & Iron Range R. R., and it ended at the mouth of the river where it flows into the St. Louis River, near Brookston, a distance of 71.7 miles.

In these surveys it was the intention to secure enough data to determine the water surface of the rivers at a medium stage, and to map the shores of the river, adjacent topography and other natural or artificial features which effect the feasibility of water-power development. This information was to be plotted to a scale of 1,000 ft. to 1-in., and was intended to serve as a general guide to persons interested in the development of water powers on these rivers.

METHODS.—The field work of the survey consisted in running a magnetic stadia traverse up the stream, carrying levels, which served for the primary control. Additional information was obtained by side shots from the main traverse, by pacing, and by hand leveling. Bench marks were set at frequent intervals. In addition to the ordiary routine, stadia correction was determined, observations were made for magnetic declinations, adjustments of transit were made, and ties to section lines were obtained.

The surveying party consisted of four men; a chief of party, who acted also as recorder, an instrument man, and two rodmen.

The magnetic stadia traverse was of the usual type. The transit occupied alternate stations, with the rods held on firm turning points for the other stations. Length of sights varied from 200 to 1,400 ft.

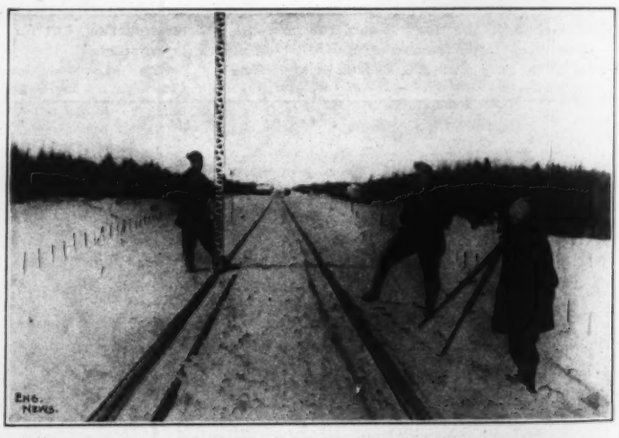


FIG. 1. RUNNING LEVELS TO RAILROAD BENCHMARK, ST. LOUIS RIVER SURVEY, MINNESOTA.

To clearly explain some novel features of this traverse the accompanying sample set of notes for one transit set up should be examined.

Sta.	Dist.	Bearing. At Sta. 406	Vert level rod readings. (H.I. 1,288.59)	Diff. Elev.	Elev.
	387				
Sta. 405	383/770	S 61 E	3.00*	.....	1,285.59
			U.C.H. 6.96†		
Water surface	.....	.....	5.49	.....	1,283.10
R. Bank	171	N 88 E	....	.....	.....
House	652	N 68 W	....	.....	.....
Sta. 407	195/387	N 36 W	5.42	.....	1,283.17
			U.C.H. 7.37		

*Middle cross hair level reading. †Upper cross hair level reading.

*U. S. Geological Survey, Old Capital Bldg., St. Paul, Minn.

The procedure was for the transitman first to turn to the rear station, and read in order level reading, upper (or lower) cross-hair reading (all with telescope level), half-stadia interval, and whole stadia interval, and magnetic bearing. The same procedure would then be followed with the head station.

The object of reading one other than the middle cross-hair, and the half-stadia interval was to check the level reading and the whole stadia interval. It was but the matter of a few seconds for the recorder to compute these figures, and to call for rereading if a discrepancy of over 0.02 or 0.03 ft. was found.

Water surface elevations were taken at each transit station and at various additional points. In order to reduce these to a medium stage of river, gages were read daily by local observers at two places on each river. The methods of locating river shore line and of obtaining topography varied somewhat, but were either by side shots, or by pacing and hand leveling.

The usual procedure was to set the traverse stations on the ice near the shore line. At each station (both transit and rod stations) the distance to each bank was paced, and a line of hand levels was carried back over the bank, the distances being paced. In addition a number of side shots were taken. Thus the survey became resolved into a traverse along the stream with a side profile every few hundred feet, and with additional data when required. Temporary bench marks were placed each noon and night. Permanent benches were placed at all entering streams of fair size, at all road and railroad crossings, at all dams, and at other places where it was believed they would prove most valuable. In the course of the survey three lakes were crossed. A magnetic traverse was carried around each lake near the shore, and lines of hand levels carried back over the banks after the manner of the river surveys.

A 5-in. transit was used, equipped with stadia wires, telescope bubble, and half vertical circle. The stadia rods were 4 ins. wide and 12 ft. long, painted in black mass figures on a white background, to enable them to be read easily at a distance. The divisions on the rods were to 0.05 ft. with hundredths interpolated.

It was found imperative to guard against error in the level line due to settlement of transit and of rod stations into the ice, and due to variations in the elevation of the ice with changing stage of river. Considerable attention was paid to this question and without going into detail in the matter it may be well to state the conclusions arrived at.

During weather when the air is below freezing temperature, neither the transit nor the nails marking the other stations will sink into the ice. When the air is above freezing temperature, however, the nails and the iron points of the transit legs conduct the heat of the air to the ice and cause settlement. Measurements made during thawing weather showed a settlement of nails amounting to 0.02 ft. and of the transit amounting to 0.03 ft. during the time that a station was occupied. Settlement of rod stations was prevented by using a "station marker," this being a board roughly 6 by 8 ins. with a 20-penny nail driven through the center. The nail was driven into the ice and the marker served much like a large thumb tack. The wood did not conduct heat enough to settle into the ice. Similar boards might have been used under each leg of the transit. The procedure followed, however, was to keep the transit on shore whenever possible, and when set-ups were made on the ice to take the level readings of rear and head rods in quick succession, thus allowing minimum time for settlement. Readings of distance, etc., were then left until after all these level readings had been taken. When snow covers the ice, this serves as a non-conductor around the points of the transit legs and tends to reduce transit settlement to a minimum.

During a change of the stage of a river, it was found that the elevation of the ice surface is likely to vary considerably. On a wide stream, the ice cover is practically in a state of flotation. This can be seen quite readily by considering the ice cover as a plate supported at the shores. It fails by shearing near the supports with any considerable change of stage. This effect was especially noticed on wide portions of the streams where cracks were almost always present running along the shores. On narrow streams when the ice cover is thick it will often take quite a considerable change in stage of water to change the ice elevation. The best way to avoid errors due to this partial flotation was found to be to keep the transit on the ice at the shore, or at places where no rise or settlement was to be expected.

Transportation and Subsistence.

The St. Louis and Cloquet River surveys were essentially camping expeditions. At many places it was possible to find stopping places, but it was necessary to be prepared to camp at any time. The camping outfit was reduced to a minimum and was of such size as could be carried on two 7-ft. toboggans drawn by two men. The friction of the toboggans on

Fig. 2. Winter Camp Outfit Packed For Hauling; St. Louis River Survey, Minnesota.

the snow varied greatly, so that a proper load was not constant. However, it was found that 150 lbs. per toboggan was about the maximum allowable load. The outfit found desirable for the four men of the surveying party comprised four sleeping bags, three comfortors, one canvas sheet (12 × 14 ft.), steel dishes (a four-person, Armour, steel outfit), a pack sack for notebooks, small instruments, etc., and in addition a supply of provisions. It was impossible for any considerable amount of extra clothing to be carried. One extra change of clothing was taken for use in case a man should fall through the ice. Miscellaneous extra footwear was carried also. The provisions were based upon the U. S. Army ration list, but only such things were carried, however, as could be cooked over an open fire.

Camps were made at intervals of from six to twelve miles depending upon local conditions. This made shifts of camp occur about once in every four days. Whenever possible camp was made in old logging camps where there would often be a stove; otherwise camp was made in the best shelter to be found and cooking was done mostly over open fires. Temperatures as low as 36° below zero occurred and the outfit proved satisfactory, even under these conditions. It would have been impossible to have made runs of indefinite length, but distances of 20 to 25 miles between supply points were not too great.

Transportation of this outfit was usually done by men and harnesses were made with which to haul the toboggans (see Fig. 2). Over smooth ice a shift of 12 miles was made one day without difficulty, including making and breaking camp. In deep snow it was more difficult, the maximum shift of camp under these conditions being ten miles.

Errors.

That portion of the survey, from the mouth of the Cloquet River, running up the St. Louis River, crossing to the Cloquet River, and running down the Cloquet to its mouth forms a circuit composed of 207.8 miles of traverse and 15.9 miles of wye levels. The levels for this circuit closed with an error of 1.16 ft., the final elevation being high. The wye levels between the St. Louis and Cloquet rivers carried as a double rodded line, showed a deviation for 15.9 miles of 0.05 ft.

Cost Data.

ST. LOUIS RIVER SURVEY.—The party was in the field on the St. Louis River 59 days, of which several were used moving camp. The whole work may be summarized as follows:

Elapsed days	59
Number of working days	50
Miles of river surveyed (from traverse along river bed)	155.7
Number of traverse stations	971
Average miles per working day	3.1
Average miles per elapsed day	2.6

	Cost	
	Total.	Per mile.
Field	$1,041.55	$6.69
Supervision	93.74	.60

The field cost of $1,041.55 was divided as follows:

Services	$711.66
Transportation	73.00
Subsistence	242.61
Supplies	14.28
Total	$1,041.55

In addition to the regular river traverse of the St. Louis River, the following traverses were run and are included in the cost of the St. Louis survey.

Entering streams	2.7 miles
Road traverses	3.8 miles
Wye levels	8.5 miles

CLOQUET RIVER SURVEY.—The party was in the field on the Cloquet River 36 days, of which several were used moving camp. The work here may be summarized as follows:

Elapsed days	36
Working days	31
Miles of river surveyed (from traverse along river bed)	71.7
Number of traverse stations	462
Average miles per working day	2.3
Average miles per elapsed day	2.0

	Cost	
	Total.	Per mile.
Field	$637.01	$8.88
Supervision	35.91	.50

The field cost of $637.01 was divided as follows:

Services	$446.64
Transportation	36.55
Subsistence	148.67
Supplies	5.15
Total	$637.01

In addition to the regular traverse of the Cloquet survey, 1.5 miles of traverse were run up entering streams, 9.1 miles were run around lakes, and 8.5 miles of wye levels were run; all this work is included in the cost given above.

The general charge of these river surveys has rested with Mr. Robert Follansbee, district engineer of the U. S. Geological Survey for the Minnesota district. The writer acted as chief of party on the field work.

MOSQUITO-PROOF STEAMERS for service in tropical waters are being built by John Holt & Co., of Liverpool, England, and will be put on the company's West African line. According to a published statement all skylights, portholes, etc., will have copper screens of fine mesh, and double doors of the same material will be fitted to the staterooms, saloons, crews' quarters, etc. Last year the company equipped in this way the small steamer "Axholme," built for service on the Niger River. It also applied similar screens and screen doors to a large building for the accommodation of the staff at Cape Lopez, while the veranda was enclosed entirely with the mosquito-proof copper netting. Results in reducing mortality and disease are said to have been marked.

Hammer Drills for Overhand Stoping and Raising in Gold Mines.*

By H. B. WILLIAMS.

The numerous advantages obtained by the recent substitution of hammer drills in place of hand labor and ordinary piston drills having now been sufficiently demonstrated by means of exhaustive trials and practical operation in stoping and raising at the Granite Gold Mines, British Columbia, I herewith append an account of my experience of their performance.

Overhand or back-stoping only is practised at these mines, the reef consisting of hard quartz from 8 ins. to 5 ft. in width, containing 2% to 10% of sulphides of iron and arsenic, while the country rock is a dark close-grained granite. The vein underlies at angles varying from 35° to 50°.

Figures being available to show the cost of stoping as practised in previous years at the mines, this paper is written with the object of a general comparison of results by the various methods employed, and in particular with regard to those obtained with the hammer drill. The drill found most efficient is the Waugh stoping hammer drill, a 2-in. cylinder, valve machine. The principal wearing parts are the piston hammer, costing $4, the chuck $3.50, tappet $2 and complete valves $10.

Construction and Operation of the Hammer Drill.

A general description of the mechanism of the machine in question is as follows: Referring to Fig. 1, the drill is 4 ft. in length, weighing 60 lbs.; its greatest outside diameter being at the barrel, 3¼ ins. The cylinder diameter is 2 ins. The automatic telescope air-pressure feed allows of an extension of 24 ins. The hammer is a piston the blow of which is regulated by the valve. The hammer strikes a tappet which in turn delivers the percussion to the end of the shank of the drill steel, which is held in alinement with the drill in a hardened steel chuck. Rotation of the machine, and consequently of the drill steel, is effected by means of the hand lever. With an air pressure of 60 lbs., 1,000 blows per min. are struck by the hammer, its stroke being 2½ ins.

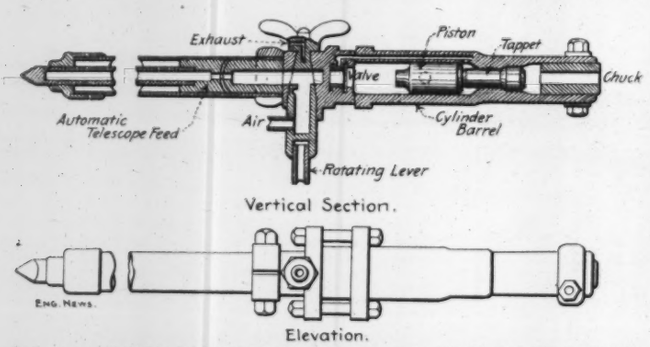


FIG. 1. HAMMER ROCK DRILL USED AT THE GRANITE GOLD MINES, BRITISH COLUMBIA.

In operation underground, a starter is first placed in the chuck and the hose coupled to its connection. The drill is then set up with the extension end on a rough block (Fig. 2). As previously stated, the hammer drill is designed for the boring of uppers in overhand stoping and raising only. The block may be laid on broken ore or across the stope timbers at a convenient distance from the fact of the stope, and the machine is so alined as to take the best advantage of the heads occurring in the ground to be broken. Air is now turned on, the extension piston automatically brings the bit forward into contact with the rock, percussion of the drill steel by the tappet commences, and when the rotating lever is operated by the machine man, pitching and subsequently drilling of the hole proceeds to the depth required.

Holes up to 4 ft. in depth are bored by these machines. The drill steel used is of light cruciform section in lengths of 18, 27, 36, 45 and 54 ins. allowing 9-in. changes for each bit. It has been found important to forge and harden the drill shanks with care, 1 in. square, where they fit in the chuck, as it is at the chuck that most wear and tear occurs with these machines. It has been suggested that with only slight wear of the chuck and of the shank of the drill steel, the alinement of the machine itself and the drill steel would not coincide, and in consequence there would be a tendency to "fichured" holes. Experience at the Granite Mine, however, has proved to me that the number of fichured holes is small, although the ground is "heady." Difficulty is experienced only when the drill bores into soft gouge which occasionally occurs on the hanging wall.

It has been found more satisfactory to avoid the boring of holes at an angle of less than 35° from the horizontal. At smaller angles the dust does not clear from the holes by gravity, and owing to the unsupported length of the machine and drill steel the leverage is sufficient to cause the drill steel to break, usually close to the chuck, and to wear the hole in the chuck itself unduly; moreover, considerable additional friction and consequent loss of boring efficiency is caused by the boring of flat holes. With a reef underlying at over 35°, as is the case with the Granite Mines, there is only occasional necessity for a low-pitched hole.

Machine men running the hammer-drills are instructed to attend carefully to the lubrication of their machine, which is essential owing to the somewhat delicate mechanism of the valves. Recently an automatic lubricator has been supplied combined with the air-connecting plug, which now ensures constant oiling of the machine for a full shift without replenishing the oil-chambers.

Advantages of Hammer Drill Over Piston Drill.

I now propose to deal with the advantages of the hammer drill over piston drills manifested in the tests underground, which led to the final adoption of the former at the mine for stoping and raising.

The lightness and general handiness of the 2-in. hammer drill, its weight being only 60 lbs. against the 125 lbs. of the 2-in. piston stoping drill, is a point in its favor.

There is a considerable saving of time in setting up. In a shift of eight hours, it can be safely estimated that the loss of boring time in setting up, changing steel and taking down a piston drill is two hours; with the hammer drills half an hour only per shift is sufficient, less time is lost in changing steel, there being no U-bolts, bars, or mountings to manipulate.

Inexperienced hand-labor miners can learn to run the hammer drills in a few shifts, a great advantage in a country where good machine men are difficult to procure.

Greater drilling efficiency has been obtained. With the small 2-in. one-man piston drill, a shift's work comprising a total footage bored of between 25 and 30 ft. was considered satisfactory, whereas the hammer drills bore ten 4-ft. holes, or an aggregate of 40 ft. per shift. The bitts of the drill steel are not dulled by the quick, light blows of the hammer drill to the extent which occurs with the heavier blows from the piston drill.

Owing to the fact that the hammer drill is so compact and requires no bar or mountings, holes may be bored to take the greatest advantage of slips in the ground in low stopes, and greater efficiency in breaking ground has resulted.

The construction of the hammer drill renders its adaptability most evident for carrying considerably lower stopes than with the piston drill, a great saving of cost in stoping narrow reefs, such as those of the Granite Mines.

I have been struck with the small quantity of fine dust made by the hammer drill in the stopes and rises. I account for this improvement over piston drills by the fact that there is no churning movement of the drill steel in the hole, as is the case with the piston drills, the bit of the drill steel being held continually in the bottom of the hole while boring. The air is exhausted back from the face of the stope and no air can escape at the chuck end of the machine. It may also be noticed that the hammer drills possess the advantage of producing coarser cuttings than the piston drill.

In air consumption I have found that with a receiver pressure of 80 lbs., there is only a slight advantage in practice in favor of the 2-in. hammer drill over the 2-in. piston drill.

REDUCTION OF COSTS.—Having related the advantages of the hammer drill over the piston drill, as proved by their successful operation for some months past at the Granite Mines, I now propose to deal with the reduction of costs in stoping effected by their use. A comparative statement of stoping costs under various methods is as follows:

Stoping by hand labor	$3.50	per ton
Stoping by 3¼-in. rock drill (piston)	2.90	"
Stoping by 2¼-in rock drill (piston)	2.08	"
Stoping by 2-in. hammer drill	1.53	"

In the above statement no allowance is included for development charges, compressed air, or depreciation of plant generally. In reference to this point, however, it may be of interest to mention that the total costs, including all charges of mining transportation, milling and realization, etc., at the Granite Mines, have recently been reduced from $5.32 to $3.25 per ton, although the high cost of labor and supplies locally shows no diminution. The reduction is mainly attributable to the adoption of the hammer drills. It must be borne in mind, in considering the value of the above figures in comparison with costs at larger mines, that they refer to a mine equipped with a plant capable of crushing only 1,500 tons per month, and that the greater proportion of the stopes worked recently carry a reef with an average width of only 15 ins.

On account of the simplicity and small number of moving parts, the repairs and general upkeep of the hammer drills work out at approximately only $1 per month, which compares favorably with these charges in the case of the piston drills. Owing to its compact tube-like design, the hammer drill withstands the invariably rough handling without the breakages so common with piston drills. The advantages in general handiness, increase in progress and consequent reduction of cost with the hammer drill are even more marked in raising than in stoping.

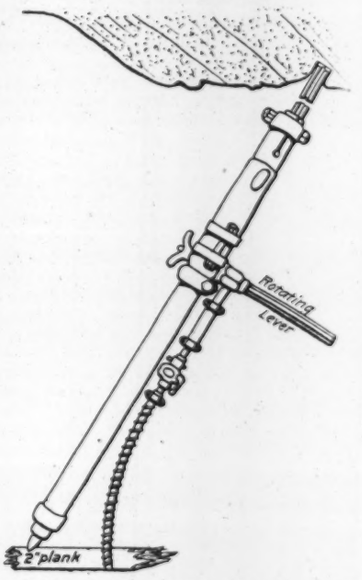


Fig. 2. Hammer Rock Drill in Operating Position.

*A paper presented at a meeting of the British Institution of Mining and Metallurgy, April 21, 1910.

ALMOST A BILLION DOLLARS were paid to railroad employees in the United States in the fiscal year 1908-9, according to advance pages of the annual report of the Interstate Commerce Commission. The actual figure was $908,323,694, which was distributed among 1,502,821 employees.

A NOVEL GASOLINE OMNIBUS.—An interesting design of motor omnibus has been developed by the Daimler Co. for service in London. The most conspicuous and radical departure from old ideas is the abandonment of the chassis or frame. The bottom of the steel wagon body takes the place of the usual frame. This part of the body is a big channel built up of sheet-steel. At the point of load application to springs, riveted cross members serve as body stiffeners and under the driver's seat is a fitted gasoline tank, riveted to the body to secure torsional rigidity. The upper part of the carriage is of steel, built directly upon the body bottom. There is also an upper deck.

Large wire-spoke wheels (40-in. front and 48-in. drivers) are shown. The drivers are mounted on short drive axles carried by a bent tubular axle tree. On each side of the body is a power unit for each driver, the transmission being through worm gearing. Each power unit is a 12-HP., four-cylinder, gasolene engine. The crank shafts are extended and on each is mounted a 3-KW., shunt-wound, six-pole, electric motor. Each unit is placed on one side with the crank shafts extending longitudinally to the short drive axles of the rear wheels. No differential gears are interposed between the engine and the driver, but a magnetic clutch makes the connection. A storage battery is carried, and, when the load is heavy (as at starting), it supplements the engine. In times of light running, the motors run as generators charging the battery. Reversal is effected by the motors alone and in series. Speed is indirectly controlled (between 3 and 14 mi. per hr.) by changing generator voltage with the motor-field rheostat; when the battery voltage falls below a certain value a solenoid governor operates the engine throttle to increase speed and vice versa.

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The old difficulty of how to specify for public-works contracts receives interesting discussion in Mr. Creuzbaur's paper, abstracted in this issue. The most useful part of the paper, we believe, is the citation of actual cases of trouble produced under this or that form of contract. Contract clauses must be built up from experience, from *bad* results. Theorizing can only afford a general guide; contracts under which efficient, frictionless working was obtained are merely negative evidence, testifying more to the excellence of the contractor and the fairness of the engineer than to the perfection of the form of contract. For this reason it will be valuable to have fuller collection of cases of trouble under public-works contracts.

The trouble is that two sides must be regarded in framing contracts: the contractor needs to be assured against arbitrariness on the part of owner or engineer just as fully as the owner's party needs to be protected against possible greed and lack of conscience of the contractor. The old legal view that the engineer is a third party—an impartial arbiter standing between contractor and employer to protect each against the other—does not seem to fit well in public work. For here the owner is intangible, existing concretely only in the person of the engineer, and there is no third party. Under these circumstances the dogma that the engineer is sole judge and arbiter of everything is too partisan. The contract must fix a definite basis on which it will be possible to estimate with fair certainty the cost and conditions of the work to be performed. For this very reason, however, contracts which leave the amount and kind of work wholly in the air, for subsequent determination by the engineer, are imprudent. And devices whose sole merit is to increase the flexibility of a contract—to facilitate changes and additions—are not recommendable.

The subject of time of performance, penalty (or damages) for non-completion or delay, etc., is perhaps the most important item which Mr. Creuzbaur fails to discuss. This is eternally a sore point in public work. Private employers can usually compel reasonable adherence to contract time. Public-works contracts are very little protected in this regard. Improved means of fixing damages for delayed completion are very much needed, especially means which the courts will consent to enforce.

Two more night-prowling attempts to blow up bridges are the recent contribution to a shameful record. At Bayonne, N. J., and at Pittsburg, Pa., the explosive-handlers tried to wreck bridges, both not yet completed and both still in charge of the bridge-building firms (Eng. News, July 21, 1910, p. 83.) As in most of the previous cases of the same kind, the damage done was relatively small. The evidence is clear—when all the bridge-dynamiting outrages of the past four or five years are taken together—that the motive is an insane form of labor-union spirit, attempting to wreak cowardly revenge on "open-shop" contractors.

A sinister feature of the black record is that in no single case have the police powers apprehended one of the criminals. A dozen cities at different times were the scene of "work" of this kind, and of course the same number of different police organizations had a chance to show results, instead of which they usually gave a picture of masterly inactivity. To put an end to this incipient terrorism we must look to the formation of a strong public sentiment, and in forming this the engineer should lead.

The chronicle of these dynamiting cases includes ten or fifteen bridges, several buildings, and some items of contractors' equipment (as where, instead of attacking the structure, it was sought to blow up a contractors' hoisting-engine). A number of contractors have been the object of attack. In one or two cases guy-ropes have been cut—a closer imitation of the despicable French system of "sabotage" than this country can tolerate.

In the beginning the bridge-dynamiting gang chose only uncompleted structures for its attack. This at least avoided the risk of killing passengers. But some of the later attempts were made against structures already opened to traffic and in the Pittsburg case, July 15, 1910, the structure was just about to be opened. It is only a small step further to attack in the same way any and all bridges or buildings, whether occupied or not. We trust that before this point is reached the criminal activity will have found its due retribution.

The transportation of freight in large cities is one of the many problems relating to the improvement of rapid transit methods, as the increasing traffic of heavy and slow-moving wagons tends to increase the congestion in busy streets and tends also to block and hamper the movements of lighter vehicles and street cars. In most cases, however, the removal of the street cars from the surface to a subway is the method of relief considered. One important division of the heavy traffic is the transportation of freight between the railway terminals and commercial warehouses, and in some cities an attempt to reduce this has been made by establishing large warehouses near the terminals and having railway track connections. Commercial houses can rent suitable accommodation in these buildings, and there receive and ship goods direct. Several cases of this kind have been described in our columns.

An entirely different system is that of providing underground transportation of freight traffic, and so far as we recall Chicago is the only city where such a system has been put into service. This system is referred to in another column, in connection with the coal and ash handling equipment of a large office building, and while it has been described in some detail in our columns it is worth while at this time to call attention to the novel method of transportation. The company operating this system has now some 50 or 60 miles of small tunnels with a single-track narrow-gage railway system operated by electric locomotives. In the downtown district, there is a tunnel under nearly every street, and connecting curves are provided at nearly every intersection, so that there is great flexibility of movement. Numerous spurs and sidings are run under individual buildings, such as wholesale and retail stores, department stores, newspaper offices, freight houses, factory and office buildings, etc. Where there are no deep basements, elevators carry the tunnel cars to the main floors, but in many of the modern buildings having three or four floors below the street level the cars enter the basement, and goods are handled by the ordinary elevator service of the building. The class of freight handled is very comprehensive; commercial goods of all kinds are received from and shipped to warehouses or freight stations. Coal is delivered and ashes are removed; at building sites, temporary chutes or shafts are built and the debris from wrecked buildings as well as material excavated from foundations is shot into tunnel cars standing beneath. As to these last classes of material it is to be noted that the underground transportation system relieves the streets not only from the numerous slow-moving wagons but also from the dirt and dust due to hauling such material through the streets. At one time the company had a contract for handling mail between the railway stations and post offices. When the contract expired, it was not renewed on account of a dispute over the terms, and the post-office department returned to the old wagon system.

It may be noted that the tunnel system was not designed originally for its present purpose. When a new telephone company received a franchise for an automatic telephone system, surveys showed that in many of the streets there was no room for the necessary conduits and the bold move was made of building a system of small tunnels at such depth as to be not only free from interference with sewers, pipes, conduits, etc., but also from interference with a projected shallow-depth subway system for street cars. The tunnels are 6½ × 7½ ft. inside the concrete lining, and as originally planned they were to contain steel horse-shoe ribs having arms with insulators for the wires and cables, leaving a narrow passageway in the middle. At the present time the telephone business is secondary to the transportation business, and the latter presents a decidedly novel method of freight transportation.

It has been suggested that if the present use had been foreseen, the tunnels might have been made large enough to accommodate ordinary railway cars, but it is doubtful whether the results would have warranted the much higher cost and greater risk. With the small cars there is greater flexibility of distribution, a few tons of mail or freight or coal can be distributed promptly to or from several points while it would be cumbersome or impracticable to serve all these points with railway cars. On the other hand, it seems doubtful whether a freight-handling system of the kind now developed would have been regarded as practicable at the time the tunnel system was first established, and a project for handling freight by a narrow-gage underground railway system would have received probably very little support.

For the second time within three months the records of the Bureau of Public Health of Philadelphia show no deaths from typhoid fever during a whole week. For the entire month of June only 13 deaths were recorded, as against 669 for the corresponding month of 1906. With the gradual extension of the filtered water-supply the typhoid mortality decreased year by year from 72.4 per 100,000 for 1906 until for 1909 it was only 21.2 per 100,000. The records for the first half of 1910 indicate a notable further reduction for the current year. While it is not probable that this good record is entirely due to filtered water, there seems little question but what an elimination of typhoid germs from the water-supply is the chief cause of the reduction of typhoid mortality. This should give reassurance, if that be needed, to those whose confidence in the value of water filtration has been shaken by the experience of Washington, D. C., where the expected decline of typhoid death rate did not follow the introduction of filtered water. Other causes than the water-supply, as we have often pointed out

in the last few years, must be responsible for the continued high typhoid mortality in Washington. It should be noted, however, that Washington has not been scourged with typhoid to the extent experienced by Philadelphia.

A remarkable state of affairs has arisen at Los Angeles, Cal., where the engineers in charge of the construction of the long aqueduct which is to supply the city with water from the high Sierras have pushed the construction at so rapid a rate that delay has been threatened through lack of funds. It appears that bonds were sold under an agreement with an Eastern bond house to take them in periodic instalments. The work has progressed so rapidly that the city has made requests for money in advance of instalments due, the bond house not having acceded to the request for delivery at a rate higher than that specified in its contract. The city authorities have been faced with the alternative of slackening the work or securing temporary loans. Such a state of affairs is sufficiently remarkable to warrant putting it on record. There is reason to believe that the city officials and citizens of Los Angeles will find some means of providing the engineers with money to continue their good work of rapid construction.

A new and hopeful sign of the times was the gathering of the mayors of 42 of the 45 cities of New York State in a conference to discuss city health matters a few days ago. Various phases of the subject were considered, presumably much to the enlightenment of those in attendance. Before returning to their respective cities to put into practice the theories and principles which had been discussed, these mayors adopted resolutions, according to reports, pledging themselves to try to secure larger appropriations for public health work in each of their cities. Furthermore, and of much significance, they agreed to work for the elimination of politics in city health matters and for state legislation to protect health officers from removal for other causes than the good of the service.

Another conference will be held at Poughkeepsie later on. It is to be hoped that similar conferences will be held in other states. If conducted in cooperation with state boards of health and the more efficient of the local health officers of the state, such conferences would doubtless give a marked impetus to public health-protective work throughout the country.

The Future River and Harbor Policy of President Taft.

In signing the River and Harbor Bill passed by Congress a month ago President Taft attached a memorandum which we have faith to believe will go down into history as marking the beginning of a new epoch in the conduct of our river and harbor improvements. To believe this, as we do, requires great faith, since the memorandum is prophetic of a time when those picturesque terms "log rolling" and the "pork barrel" will have disappeared from the discussions of river and harbor appropriations.

The essence of President Taft's memorandum partook largely of the nature of a protest against small appropriations and piecemeal construction in river and harbor work, an argument for expeditious construction of each improvement undertaken, *after careful investigation and judicious selection*, and a warning that in the future he would veto any river and harbor bill not drawn along these lines of reform, as he came near vetoing the bill of the present year.

The memorandum is, of course, worthy of being placed on record somewhere in our columns, and for purposes of convenience in connection with our remarks upon it, it is reprinted here. The side heads and italics, it is only fair to say, are our own. The memorandum is as follows:

MAIN FEATURES.—The bill is an important one and contains many excellent features. It provides for the canalization of the Ohio River, to be prosecuted at a rate which will insure its completion within 12 years; the improvement of the Mississippi River, between Cairo and the Gulf of Mexico, to be completed within 20 years; of the Mississippi River, between the mouth of the Missouri and the mouth of the Ohio River, to be completed within 12 years; of the Mississippi River, between Minneapolis and the mouth of the Missouri River, to be completed within 12 years; of the Hudson River, for the purpose of facilitating the use of the barge canal in the vicinity of Troy, N. Y.; of the Savannah River, from Augusta to the sea, with a view to its completion within 4 years; of a 35-ft. channel in the Delaware River, from Philadelphia to the sea; of a 35-ft. channel to Norfolk, Va.; of a 27-ft. channel to Mobile; of a 30-ft. channel to Jacksonville, Fla., and of a 30-ft. channel to Oakland, Cal. It also provides for greatly enlarged harbor facilities at certain important lake ports, including Ashtabula and Lorain, and enlarged facilities for the important commerce of the Detroit River. Indeed, it may be said that a great majority of the projects named in the bill are meritorious and that money expended in the completion will not be wasted.

CHIEF DEFECT.—The chief defect in the bill is the large number of projects appropriated for, and the uneconomical method of carrying on these projects by the appropriation of sums small in comparison to the amounts required to effect completion.

The figures convincingly establish the fact that *this bill makes inadequate provision for too many projects.* [The italicized portions throughout are ours.—Ed.] The total of the bill—$52,000,000—is not unduly large, but *the policy of small appropriations with a great many different enterprises, without provision for their completion, is unwise.* It tends to waste because, thus constructed, the projects are likely to cost more than if they were left to contractors who were authorized to complete the whole work within a reasonably short time. The appropriation of a small sum lessens the sense of responsibility of those who are to adopt the project, and who do not, therefore, give to their decision the care that they would give if the appropriation or contract involved the full amount needed for completion. Moreover, the appropriation of a comparatively small sum for a doubtful enterprise is thereafter used by its advocates to force further provision for it from Congress on the ground that the investment made is a conclusive recognition of the wisdom of the project, and its continuance becomes a necessity to save the money already spent. This has been called a "piecemeal" policy. It is proposed to remedy this defect by an annual river and harbor bill, but that hardly avoids the objections above cited, *for such yearly appropriations are likely to be affected by the state of the Treasury and political exigency.*

THE PROPER METHOD.—If enterprises are to be useful as encouraging means of transportation they ought to be finished within a reasonable time. The delays in completing them postpone their usefulness and increase their cost. *The proper policy, it seems to me, is to determine from the many projects proposed and recommended what are the most important and then to proceed to complete them with due dispatch, and then to take up others and do the same thing with them.*

There has been frequent discussion of late years as to the proper course to be pursued in the development of our inland waterways, and I think the general sentiment has been that we should have a comprehensive system, agreed upon by some competent body of experts, who should pass upon the relative merits of the various projects and recommend the order in which they should be begun and completed.

Under the present system every project is submitted to army engineers, who pass upon the question whether it ought to be adopted, but have no power to pass upon the relative importance of the many different projects they approve, or to suggest the most economical and businesslike order for their completion.

General Marshall, while Chief Engineer, at my request, furnished me a memorandum in respect to the bill, then pending in the Senate, in which he analyzed the criticisms made in the discussion of it in Congress. He considers the bill to be quite as good as any of its predecessors, but points out the defects I have mentioned above, and also suggests that the old projects provided for in the bill include some which were never recommended by the engineers and some which, though once recommended, would not now be recommended because of a change of condition.

Congress should refer the old projects to boards of army engineers for further consideration and recommendation. This would enable us to know what of the old works ought to be abandoned. General Marshall's plain intimation is that a number of old projects call for action of this kind.

A NARROW ESCAPE FROM VETO.—I have given to the consideration of this bill the full ten days since its submission to me, and some time before that. The objections are to the system, for it may be conceded that the framers of the bill have made as good a bill as they could under the "piecemeal" policy. *I once reached the conclusion that it was my duty to interpose a veto in order if possible to secure a change in the method of framing these bills.* Subsequent consideration has altered my view as to my duty.

A WARNING.—It is now three years since a river and harbor bill was passed. The projects under way are in urgent need of further appropriation for maint[enance] and continuance, and there is great and justified [anx]iety for many of the new projects provided for [in the] bill. *It has been made clear to me that the fail[ure of] the bill thus late in the session would seriously em[bar]rass the constructing engineers.* I do not think, therefore, the defects of the bill which I have pointed [out] will justify the postponement of all this important [work]. But I do think that *in the preparation of the pro[jects for] future yearly bill Congress should adopt the rule above suggested and that failure to do so would justify withholding executive approval, even though a river and harbor bill fail.* WILLIAM H. TA[FT]

We are tempted at the outset to express regret that the President did not see his way clear to veto the present bill, but in view of the complexities of the case and the fact that, as he says, it has been three years since a river and harbor bill was passed, and that the engineering engineers would have been seriously embarrassed had the present bill utterly failed, we refrain—particularly on taking into account the strong protest and warning which has been put on record. But we will go so far as to say that had so clear cut an opinion been formulated and uttered earlier in the session perhaps some measure of reform might have been included in the present bill, and to suggest that had no bill whatever been passed any of the army engineers thus left idle might have been profitably employed on studies of a rational course of future action.

The weaknesses and extravagances of the present system of making appropriations have been commented on more than once in these columns. We interpret President Taft's remarks on the subject as being in substantial accord with ideas which we have already expressed and which, we believe, are held by practically all engineers—and by the citizenship of the country generally, wherever the subject has been considered broadly, or with freedom from the narrow and selfish viewpoint of a local appropriation. At the same time, the program suggested will never be put into effect without a large amount of disinterested work on the part of all who appreciate the need for reform. The bulk of this work, since public opinion must be aroused, educated and directed, will fall upon the daily, weekly and monthly press.

The members of the engineering profession can and should contribute much to this educational campaign. They, better than men of any other class, can appreciate the economic folly of entering upon huge ultimate expenditures when there is no prospect of completing the work for years to come. They can appreciate as can few others how desirable it is to determine the relative importance of the many improvements being urged upon Congress and to choose for early execution those of greatest feasibility and lowest relative cost. By bringing home these principles in public and private discussion, and through the press, engineers can do much to stop the gross waste of public funds which has characterized our past river and harbor work, and which without strong and sustained protest will continue for years to come.

We presume no one understands better than does the President that the new policy which he advocates must again be brought to the front at the earliest possible day, and kept to the front until some effective steps are taken to secure its adoption.

It is really too much to hope, we fear, but it is highly desirable, that as soon as Congress again convenes it pass the legislation necessary to initiate a thorough study of the whole question of river and harbor appropriations, with a view of determining the relative importance of each of the many projects and the time and money which might properly be allowed for their completion. That done, each project should be taken up in order of its importance and feasibility, and put through in the same expeditious manner as would be pursued by a private individual or large corporation wishing to realize on a heavy investment by getting its undertaking into full operation as speedily as possible. Unless Congress puts such an investigation under way at an early date the time for action on another river and harbor bill will come with

...erial change in the old piecemeal appropria-...s, fixed by familiar log-rolling methods. It ... be that nothing short of a veto or series of ...s of river and harbor appropriation bills ... put our river improvements on a rational ...s. It is to be hoped that the protest and ...ning of the President, backed by the good ...mon sense of the citizenship of the country, ... which Congressmen really share after all, will ...vail, and that we shall soon see established ... followed a well-conceived program for river ... harbor improvements.

LETTERS TO THE EDITOR.

Experiments on the Pressure of Concrete on Forms.

Sir: In your issue of June 30, p. 748, is an article by Mr. L. E. Ashley, entitled "An Experiment to Determine the Pressure of Concrete on Forms." In that article he makes the statement that the only practical information on the subject of the amount of wire to use to hold forms is that found in the tests of Maj. Francis R. Shunk in 1908, the results of which were published in Engineering News, Sept. 9, 1909.

Two years before the article mentioned appeared in Engineering News, the writer published a wire and bolt table in an article written for "The Cement Era." It appears also on p. 101 of his "Reinforced Concrete, A Manual of Practice," published early in 1908. It has been copied without credit in several concrete publications and is given also in at least two handbooks. This table gives the spacing of wire and bolts for walls up to 25 ft. high. The pressure was calculated to be that due to a fluid weighing 80 lbs. per cu. ft. References to the pressure exerted by concrete have been common for many years in books on concrete and the different writers have assumed it to range from a fluid weighing 80 lbs. per cu. ft. to one weighing as much as 150 lbs. The writer calculated his table in 1894 after determining by experiment that the pressure exerted on forms might reasonably be expected under certain conditions to approximate that due to a fluid weighing 80 lbs. per cu. ft. The table has been used for over 15 years and copies have been given to a number of men so that it has been pretty well tested.

The experiments were over 30 in number and simple. A concrete wall was to be built in a location where surface was important and therefore the forms should not bulge. Braces could not be used to support the forms, so that wire or bolts had to be used to tie them. As a lot of mass concrete was to be put in place close by before the wall was to be erected the opportunity it offered for experiment was taken. Near the mixing platform a strong box was made of 2 × 4-in. studding like a grain crib, the thickness of the walls being 4 ins. Six inches above the bottom a space was left on one side 8 ins. wide. The inside dimensions of the box were 18 ins. wide by 5 ft. long and arrangements were made so that a ¾-in. board could be slipped in to fill the 8-in. space on the side near the bottom. The top and bottom of the space was greased and the edges of the board were greased. The ends were bolted. The boards used were carefully selected and were cut into two, and in some cases three, pieces. One piece was placed in the box and concrete poured in until the board broke. The other pieces cut from the same board were soaked with water and tested with a breaking load to determine the moment of resistance. This was equated to the bending moment and thus the pressure found. In the bottom of the box was a slide which was pulled after the board broke and with a hose the box was at once cleaned out, the concrete being used in the mass work mentioned.

In the experiments mentioned different rates of filling were tried from 1 ft. per hour to 4 ft. per hour. The concrete was sloppy and of the consistency now generally adopted for reinforced concrete. The worst conditions showed that a pressure due to a liquid having a weight of 80 lbs. per cu. ft. might be expected and that was taken. The rate of filling mentioned by Mr. Ashley was rather slower than work is commonly done and he filled only 6 ins. at a time. A table of pressures should be made for the worst conditions. The experiments of Mr. Ashley were made when the temperature was about 2° below freezing, while the experiments of the writer were made out in the sun during a week when the temperature stood from 94° to 101°.

Yours truly,

Ernest McCullough, M. Am. Soc. C. E.

Chicago, Ill., July 7, 1910.

Sir: In your issue of June 30, 1910, p. 748, Mr. L. E. Ashley, writing on the Pressure of Concrete on Forms, makes the following statement: "The only practical information on the subject is that found in the tests of Maj. Francis R. Shunk in 1908, the results of which were published in Engineering News September 9, 1909." Then after stating and discussing the results of his own tests Mr. Ashley concluded as follows: "However, the most important result seems to be that the pressure on forms is much lower than has been shown heretofore" (in the tests of Maj. Shunk).

I consider this conclusion as entirely unwarranted by the data presented, as invalid and consequently dangerous.

Whatever criticism might be justly made of the device used by the writer in his measurements of concrete pressure on forms made under Maj. Francis R. Shunk in 1908, and described, as stated above, in Engineering News, Sept. 9, 1909, the fact remains that the results do not show any such glaring irregularities and inconsistencies as those of Mr. Ashley. For example, in the Illinois tests, at 3.7 ft. head there is a difference of 36% between the pressure registered by Jack No. 1 and Jack No. 2!

In considering the validity of Mr. Ashley's conclusion it is well to note that during the deposition of the last eleven inches of concrete the pressure increased at Jack No. 1 by 135 lbs. per sq. ft. and at Jack No. 2 by 129 lbs. or 147 lbs. and 141 lbs. per sq. ft. respectively per ft. increase in head. Moreover, from 10.30 until the interval from 12.00 to 1.20, during which interval only 7 in. of concrete was deposited, Jack No. 2 gave an average increase in unit pressure of 110 lbs. per ft. of head, as against Mr. Ashley's value of 68 lbs. given by the "average" curve, which I have considered as representing his conclusion. Much more reasonable curves can be drawn through the points plotted when cognizance is taken of the break caused by the suspension of work during the noon hour.

That Mr. Ashley's curve for Gage No. 1 is irrational is shown by the fact that its tangent at 5.8 ft. head has an inclination to the pressure axis of 1 ft. in head to 250 lbs. per sq. ft. in pressure or 67% greater than the curve for hydrostatic pressure of a 150 lb. liquid and this after the lower layers of concrete have had 4½ hrs. in which to gain strength!

It seems to me to be only a common sense conclusion that inasmuch as concrete, in setting, at least does not expand, but does continually gain in ability to maintain its shape without support from the form, Mr. Ashley's curves, all similar curves, should be headed toward the axis of head rather than toward the axis of pressure.

Adolph F. Meyer,

U. S. Jun. Engr. St. Paul District.

U. S. Engineer Camp, Mankato, Minn., July 10, 1910.

[It is apparent that there are a number of discrepancies in the tests made and reported by Mr. Ashley, but, in spite of these discrepancies, it will be noticed that the values derived by him are approximately the same as those reported by Mr. McCullough some years ago. With due regard to the tests reported by Maj. Shunk and defended by their maker, Mr. Meyer, we are inclined to believe that the pressure of a fluid of 80 lbs. per cu. ft. is more nearly approximate to the true pressure of concrete than the remarkably high values obtained by Maj. Shunk, who found that the pressure for the first few hours (until the concrete had a marked set, in fact) was equal to that of a liquid weighing 152 lbs. per cu. ft. This seems abnormally high and hardly in accordance with actual experience in form construction.—Ed.]

More About the Water-Power Situation in Wyoming.

Sir: From your editorial comment on my letter of June 25 (Eng. News, June 30, 1910) relating to "The Water-Power Situation in Wyoming," I would judge that you misunderstand my position. I am sure that your editorial of June 23 was plain. It contained nothing about "conservation" that I could take exception to. I fear that we are working in the dark to some extent. Your comments on my letter of June 25 refer to "the country-wide movement for the conservation of natural resources." Before we go further we should know what is meant by "conservation." We should know who originated the "movement" and why it was originated. Doctors disagree as to this. For instance, Speaker Cannon says that the idea originated with Major Powell. Mr. Pinchot says that it originated with Colonel Roosevelt. Out here, in the raw and uncouth West, we know that it originated with Mr. Pinchot himself.

"Conservation" is probably all right. Thus far we do not know. We have been searching for a definition of the term and of the "movement" for some time. If it means that the people are to be warned against waste and monopoly, well and good. If it means that the public resources of the West are to be capitalized simply to furnish a national revenue and to support more bureaus at Washington, then it is an iniquity that should be understood and dealt with accordingly. We have thus far seen no move which would indicate that the principle of reservation for national revenue is to be applied generally. It only pertains to those localities where there are public resources. We cannot see why Wyoming, for instance, should pay tribute to the public, national treasury when all eastern States are to be relieved. It is a burden and a dead weight on development that renders progress impossible. Every resource within a Western State should add to the wealth of that State and increase the prosperity of the people who reside there.

When the "conservation" movement is brought to final analysis you will find that it originated with a few bureau chiefs who desire to perpetuate their administrative authority. It is one of the many political plays that have been made in the last twenty years. It has appealed to eastern readers because our resources have been capitalized at fabulous figures and they have been shown that these will yield a perpetual revenue to them and to their children. The same kind of showing could be made by the people of the West should we undertake a campaign having for its purpose the levying of a national tax on all of the commerce of waters owned by the general government. Resources are for use and they are for the use of the man that is willing to undertake development. They have never been exploited for revenue. Even the Reclamation Act, which is referred to as a conservation measure, has for its object the making of homes without any idea of profit to the nation. This is the right spirit. Wyoming owns the waters within the boundaries of the State, yet these do not bring a revenue to the State. The object should be to benefit the greater number of people and not to place a special tax on any locality or on any particular line of business.

Did you ever know of a country where irrigation is necessary, where a higher use for water has been found? Can you imagine how our cities can grow or how the State can develop except by encouraging agriculture? We have been unable to promote agriculture without irrigation. Egypt has been in the irrigation business for many years. The Nile is its wealth. The public treasury is filled by the Nile—but indirectly. It makes the lands profitable and the farmer is able to pay his taxes. Do you presume that Egypt will be able to live at any time in the future without irrigation? Do you think that the arid West can do so?

We have no navigable streams. Congress has no control over non-navigable waters. This is generally recognized. New York has control of the non-navigable rivers within its borders and it applies the doctrine of riparian rights. The idea that water should be applied to the highest use has been recognized here for many years. It is impossible to transfer water rights from one use to the other without doing injury that is irreparable, except in a few instances. A right for irrigation, for instance, only gives the user the privilege to divert water when crops may need a supply. Water-power, to be successful, requires a steady flow throughout the year. Uses for municipal purposes vary with the seasons. No sane man, acquainted with the conditions of an irrigated country, would ever say that the time might come when water power will be a preferred use over irrigation. Water-power plants can be located where they will not interfere with irrigation development and this is what Wyoming is trying to encourage. This is the kind of public administration that results in lasting good. It is better to direct development so that progress will be sure and permanent, rather than to reserve all resources in order that the user may have to pay tribute to the national treasury.

Wyoming has a solemn agreement with the federal government. This cannot be changed except by the consent of the people of this state and by an act of Congress. The constitution of the state, approved by Congress, reads as follows, in so far as state control of water is concerned:

Article VIII. Section 1. The water of all natural streams, springs, lakes or other collections of still water, within the boundaries of the state, are hereby declared to be the property of the state.

If those who write so fluently about "conservation" will tell us what it means, we will be pleased. If the authorities on the subject will come here and show us any good reason for this undue excitement and this "country-wide movement" it will be gratifying. If we can be shown the states have been guilty of such administration as is deemed wasteful or in favor of monopoly they deserve some good advice at least. If those who are responsible for the "movement" can show us that they have not at all times been willing to cooperate with monopoly and to do most things that would strengthen their political standing, we will be much surprised.

It is an easy thing to fall in with a current and drift. It is not difficult to talk about conservation when one is two thousand miles away from the resources proposed to be conserved. It is another thing to try to build up a young state where nature has imposed many barriers to progress. Let the most ardent conservationist come West and attempt to install a water-power plant or to build an irrigation system. Very likely neither the original investor or his heirs will profit from the investment. He will be hounded by one department and another and when he is in position to

transact some business the federal government will want the profits that are justly due him. This rule applies to the small man and the big man alike. We have much less fear of monopoly than we have of arbitrary, bureaucratic domination. The state can control one in behalf of its citizens. Even Congress seems unable to control the other.

This is a subject that deserves some study. We trust that those who write and read will treat the matter from a broad standpoint. We have as much regard for posterity in Wyoming as have the people in New York. We understand our resources very well and are confident that our posterity will do much better than we possibly can providing the remaining public resources are not bottled up for the benefit of a few federal officers. The more development we can bring about, the better will conditions be for those who follow us. The water of the state will always belong to the state and be subject to public regulation. You will find no monopoly there. Adam might have spent his life worrying as to plight of Cain and Abel. He might have made estimates that would have convinced him that the resources of the earth would soon be exhausted and his immediate posterity would perish of cold and hunger.

I feel that engineers and engineering papers should be slow in adopting any political planks that are cut in national forests. There has been too much publicity of men and policies without careful study as to the needs of the public. Before engineers can adopt the "conservation movement" they should know whether it relates to public resources, the high price of living or the white slave traffic. In an address in New York last December Mr. Pinchot included all such problems under this one comprehensive heading. Can such a campaign develop a following among engineers?

Sincerely yours,
Clarence T. Johnston, State Engineer.
Cheyenne, Wyo., July 18, 1910.

College Degrees for Engineering Students.

Sir: The letters on this subject, published in the June 23 and July 7 issues of Engineering News, offer matter for discussion; the former, interpreted as an appeal to reason, is worthy of serious consideration, the latter communication is manifestly biased in arguments and conclusions. To assert that a man's occupation, written in a literal sense, indicates that he is possessed of, and uses a degree, is contrary to the order of intelligent reasoning. The successful attainment to practice in engineering work along particular lines, as a civil or mechanical engineer, surely entitles that person to a term descriptive of his profession; this does not necessarily signify a college education supplemented by a degree.

Are we to believe that the only veritable engineer is the one endowed with a college training? So your July correspondent infers when he states: "We judge of the training of a man by the college he has graduated from." Could anything be more inconsistent? No college education and degree ever conferred will afford a man a position and enable him to retain it legitimately, if he cannot "make good."

As intimated by "A Civil Engineer," the professional (?) degree is a joke—at times a gigantic one. I am acquainted with an E. E., of two years' standing, holding a position in the operating department of a light and power company at the munificent stipend of $65 per month; I have read an application for employment of a Berkley, 1910, graduate E. E., desiring a salary of $00 per month; another C. E., who used a 24-in. I-beam over a 12-ft. span for highway loading because "he wanted to be safe." I have wondered if this "structural designer" was aware that Bethlehem roll a 30-in. section? In brief, this is the late graduate, the acolyte, that bears a degree of import—a degree which supposedly places him in the class of the real engineer, who may, or may not, have had a college training, and who has had years of experience and practice in his profession.

Your June correspondent is right: the giving of a degree of engineer to beardless boys should be stopped, but how? The universities are constantly seeking students, whether their qualifications justify admission or not; the "college education" attracts the student, and they are of an opinion that such a degree as is conferred upon the completion of their course will hold great weight in an engineering career. When once he has it, the young engineer always uses it. Colleges are not instructing for pleasure—it's a business, and they would hardly answer an appeal which intimated the suppression of current practice, regardless of how much editing is accomplished to espouse the cause.

While Mr. R. T. Crane's remarks in his summary of his articles on education may be somewhat satirical, they are nevertheless surprisingly true:

"The college men talk as though they know all about every other man's business, and that they could manage affairs much better than the business men themselves. The college professors and teachers are prepared to give advice on all subjects. As $2,000-a-year teachers they tell us how to turn out $5,000- and $10,000-a-year business men. If the professors can tell us how to raise corn or build bridges or dig tunnels or run factories or manage stores, then in the name of common sense let us give them a chance to show us how these things should be done."

L. R. W. Allison.
1353 West 30th St., Los Angeles, Cal., July 20, 1910.

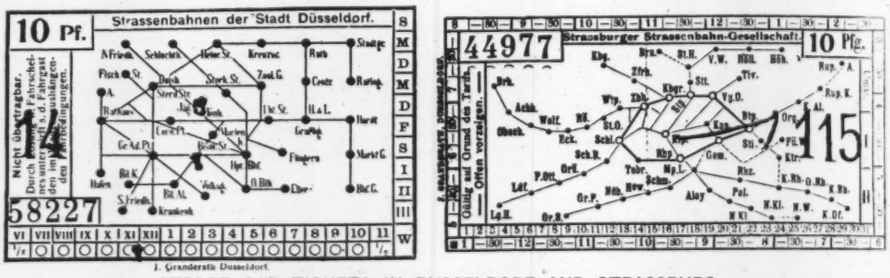
The Street Railways of Some German Cities and of Some American Cities.

(Editorial Correspondence.)

I wish I had here with me in Germany the Manager of the street railway company which operates the street railways in my own home town in America. I want to ask him some questions. I want to ask him why there is such a contrast between the street railways of these German cities and our own at home.

I have spent a short time in each of six German cities: Düsseldorf, Essen, Cologne, Bonn, Mayence and Strassburg, and have ridden on the street railways in each. What I have seen is only what may be seen by any American traveling abroad. I have not pretended to make any study of technical details of operation, and what I have seen makes me wonder why the street railway service in any and all of these German cities is so far in advance of what the public enjoys (if enjoys is the right word) in my own city in America.

What is the street railway service at home? Well, I can think of so many adjectives commonly applied to it by long-suffering passengers that I hesitate which to choose. Instead of choosing let me state the facts.



STREET CAR TICKETS IN DUSSELDORF AND STRASSBURG.

The town in which I live is a suburban city of some 20,000 population. Its street railway lines are part of a great system covering a large number of cities and towns in New Jersey and serving a population of probably three-quarters of a million people. The corporation which operates these lines is a branch of a huge corporation with many ramifications. This controls, for instance, the electric light and gas supply for most of the district covered by its street railways. Its finances are a maze, past finding out, and by common reports it has had and has more influence in shaping the government of the cities in its domain and even of the state itself, than have all the rest of the citizens of that state combined.

The end for which this corporation professedly exists is to furnish *public service* to the people over whom it reigns. But *this* is the kind of street railway service which it furnishes: Its cars are dirty and overcrowded. They are insufficient in number to accommodate the traffic, not only at the rush hours of the day but at other times. They are run at astonishingly irregular intervals. Often one waits a long time for a car to come along and then three or four will pass in a bunch. The conduct of the employees is a constant source of complaint. The handling of the controller and of the brakes is such that the cars are generally stopped with a jerk and started with a surge ahead that sends the whole mass of strap hangers swaying backward. The failure of motormen to stop when signaled is a constant exasperation, particularly on parts of the system where cars are run at infrequent intervals.

I might go on in much greater detail; but it is not a pleasant task, and the whole situation can best be summed up in one short sentence: The street railway passengers in my own city at home are jammed into dirty street-cars like cattle. The goads used upon the street-car catt[le] such verbal ones as "step lively" and "mo[ve] in front." That's the chief difference. And [there] is as yet no humane society to protect [the] railway passengers from cruel treatment.

And now how is it in Germany? In a[ll] street-railway riding in Germany, I have no[t] seen a crowded street railway car. Only [once] have I seen passengers standing inside a car [and] that was on an evening when the fireworks [dis]play in honor of Zeppelin and the Internat[ional] Congress of Metallurgy occurred at Düssel[dorf] and a crowd of many thousands was dispers[ed]. Even then the crowd was handled promptly [and] comfortably and with very few passengers st[and]ing in the aisles. The Germans recognize [the] necessity of making street-railway service f[lex]ible, to provide for variations in travel at dif[fer]ent times, and they attach trail cars behind [the] motor car. In even such small cities as Hei[del]berg, a train consisting of a closed motor [car] hauling an open trail car is regularly run.

American street railways have provided for [in]creased traffic by putting on larger and hea[vier] cars, but the Germans have met the same pr[ob]lem by running trains of two or three cars. [The] advantages of the German system to the pub[lic] are extremely great and I believe they are almo[st] as great to the street railway. The floors of G[er]man street cars are low, like the American str[eet] cars of a dozen years ago. They are far easier to get in and out of than our high-floored American cars, which are designed to accommodate the car builders rather than the convenience of the traveling public. Then with a train of two or three cars, a choice of accommodations between open and closed cars is given, as just noted. Again, these short, light cars are very easy on the track compared with the huge, heavy cars now run in American cities. This is one explanation, I have no doubt, why the track on these German street railways is far smoother than the track on any American street railway I have ever seen. Still again, it is easy and quick to provide for variation in the traffic by adding to or dropping off cars. This is one reason why German street railways actually do what no American street railway ever pretends to do—provide a seat for every passenger who wants to sit down.

Every German street-car is plainly marked inside with the number of passengers that may be seated in it and on the platforms are marked the number who may stand there. And cars enough are run so that the public is provided for without having to stand and wait. At least I have never yet in Germany attempted to board a street-car and been refused because the available places were all full.

The German street-cars are clean. They are even cleaner than the Boston street-cars; and those who know how high the Boston street-railway service stands compared with that of most American cities will appreciate what a compliment this is. Not only are the cars clean but they are attractive. They are kept well painted and varnished and they look, in fact, like [an] American car just out of the shops.

And not only are the cars clean but the em[-] ployees are clean. Their uniforms are immacu[-] late, their brass buttons shining, and the m[en] themselves are courteous to a degree that leav[es] an American dissolved in astonishment. As I have said, these low cars are easy to step on and out of, yet it is the usual and regular thing for the conductor to *get off the car himself* at [a]

where women are getting on or off, and he is there ready to help passengers if needed. street-railway passengers are not treated like tle in Germany!

nd what does the passenger pay for such eet railway service? He pays, I judge, in the e of nine passengers out of ten, the sum of pfennigs, the equivalent of 2.4 cts. in American rency. That is, he pays that sum unless he nts to ride a distance beyond the 10-pfennig it, in which case he pays 15 pfennigs or more. en you board a car and the conductor comes your fare, you tell him where you wish to go, pay your fare and he hands you a ticket on ch he punches or marks indications which w how far you are entitled to travel. The kets have printed on them a small map of the street railway system; but often printed names are used instead. This ticket is not alone a receipt for the fare paid but may be used as a transfer if you have to change from the first car to another to reach your destination. Sample tickets from Düsseldorf and Strassburg are shown on the opposite page.

It will be evident from the above description that the traffic carried on German street-railways is very small compared with the dense crowds on our American lines. American street-car conductors usually have all they can do to collect nickels and start and stop the cars. They could not possibly punch tickets according to length of journey and attend to their passengers as do these German conductors.

I said I wished I had the manager of my home street railway here. He has told me emphatically that instead of American street railways being able to carry passengers for three-cent fares, according to Mr. Tom Johnson's Cleveland program, the railways must either get more money from the public for the service rendered or many lines will go into bankruptcy.

So I want to ask him how it is that these German street railways, in cities of moderate size, can furnish a service far superior to any we have at home and with far smaller traffic can carry passengers for half the fare that American street railways charge?

My friend, the street-railway manager, has preached to me many long sermons on the horrors of municipal ownership. He has many times told me how happy and blessed we are in free America in having our municipal public utilities conducted by corporations as a private enterprise. I know by heart all his arguments against cities running their own street railways and their own lighting plants and I appreciate that many of his arguments are perfectly good and sound. I know how incompetent our American city governments are to operate street-railway lines or carry on any other business efficiently. That is why I wish I had my street-railway manager friend here. I want him to join me in frankly acknowledging that these German municipally-owned and operated street-railway lines are far, far ahead of our own American street railways in rendering good public service. I want him to join me in admiring the results of municipal operation of street railways in Germany, even if we are unable to do the same thing at home.

And now just one or two small details of operation to show that these German municipally-owned street railways are managed with brains and ingenuity. When I travel on my home street railway and the car comes to a switch, a stop is made while the motorman takes the long switch-operating rod out of the front compartment where he keeps it. Then he either gets out of the car or pokes the rod out of the front window and turns the switch. Then he puts back the rod and starts the car ahead.

On a German car when we first passed a switch, there was a pause of only a second or two and I was puzzled as to how that switch was turned; I looked for a switch tender but there was none in sight. Then I watched at the next switch and saw how it was done. The motorman carries the switch-operating rod on the front of the car outside where it is held by a socket and latch. When he comes to a switch, therefore, he can release the rod and turn the switch and replace the rod in a fifth of the time the motorman on an American car requires. It is a simple matter but it means a saving of several seconds every time a car stops at a switch, and this means dollars saved to the railway as well as to the passengers.

Now for another trifling detail that is far from trifling in its effect on public convenience and operating economy!

When an American goes from one city to another, at home, he is usually puzzled at first to know whether the street cars stop on the near or far side of the street crossings; and he never knows where other stops than at street crossings may be made. Again, in some cities with short blocks the stops are so frequent that the cars run very slowly. In these German cities the problem with which so many American street-railway managers and Boards of Aldermen have wrestled has been solved in the simplest possible manner. Of course to permit stops at every street crossing in these old cities with their maze of irregular streets is out of the question. Regular stopping places are therefore established along the line at such points as will best serve public convenience and these stopping places are plainly marked by neat enameled signs along the sidewalk.

Except at junctions with other street railway lines, these stopping places are located at some distance from the street corners. Thus the obstruction to traffic due to the street cars stopping at street corners is avoided. I believe the establishment of regular stopping places, plainly marked, on our American street railway lines would obviate four-fifths of present complaints of motormen not stopping when signaled by waiting passengers, and would also enable a considerable improvement in our street railway speeds. Again, by saving time in ways like these we might avoid some of the dangerous high-speed runs between stops, common in American cities, and some of the quick starts and sudden stops which are uncomfortable for passengers and hard on equipment, but for which the excuse offered is the necessity of making time.

And now, lest I be accused of being unjust to my friend, the American street-railway manager, I want to confess my belief that this contrast between German and American street railway service is due to some causes which are deeper seated that the first superficial view might suggest. We admire the courtesy of these German street-car conductors; and my friend, the American, tells me that he would be only too glad to have his conductors just as courteous; but where are such men to be had in America? Is not the brusque "step lively" of the American conductor just as truly typical of us as a people as is the politeness of the German conductor. Must we not as a nation learn the art of good manners before we indict my friend the street-railway manager because his conductors do not say "please" and "thank you."

Again I suspect that it is probably much easier to keep German street cars clean than American. It is not alone the papers and peanut shells which we careless Americans scatter. I suspect that these German street cars, compared with American cars, are little used by factory employees in grimy working clothes. The German mill hand lives near his place of work and walks to and fro. He is too frugal to spare even the 20 pfennigs a day which a ride to and from his work would cost. He uses the street cars after he has changed his clothes and is neatly dressed to go to some pleasure resort.

Still again, in comparing rates of fare it must be remembered that on the German scale of prices, ten pfennigs goes nearly as far as a nickel does in America. Also, German cities are compact and distances are short compared with our American cities, with their straggling suburbs. Admittedly one can ride farther in an American street car for five cents than on a German street car; but the multitude of short distance riders have either to walk or pay double what they would pay in Germany.

All these things I am sure would be ably urged by my friend the American street-railway manager in his own defence, if he were here. I think we may freely admit the truth of all of them and it will still remain true that we Americans can profit by studying German street-railway practice—and indeed all matters in connection with public welfare in these German cities.

It greatly interested me to find that while all the cities named above on the lower Rhine had municipal ownership and operation of their street railways, in Strassburg the railways were operated by a company. About the only noticeable difference was that the Strassburg cars had advertising placards inside, which was not the case with any of the city-owned cars. Strassburg, it will be remembered also, is in former French territory and it is an interesting speculation whether the franchise plan in Strassburg represents the prevalence of French ideas and systems instead of German.

It is exceedingly interesting, also, to recall that these cities along the lower Rhine were prominent among the places where in the Middle Ages the ideas that lie at the basis of modern democratic society first flourished. It was these cities, growing prosperous from the traffic of the Rhine, that first became strong enough to withstand the "robber barons" in their castles and finally drove them from these strongholds.

Far back, in the so-called Dark Ages, the people of these cities learned to stand together for protection against common enemies. They taught some of the first lessons in democracy to the world, and there are, I believe, still other lessons that we can learn from them with profit.

I do not care to draw too close a parallel between the "robber barons" who were overthrown by these free cities of the Rhine and the "robber barons" to whom we in America have bartered the right to control the streets of our cities. I know that, just as in the Dark Ages many men would have acted exactly like the "robber barons" of the Rhine if they had had possession of their castles, so nowadays many of us would like to take the place of our street railway "barons" and in their places would do likewise. As some wise man said, "Human nature is pretty much of a muchness."

The parallel that it does seem worth while to draw is the parallel between what these German cities did centuries ago in defending themselves from the extortion practised by the robber barons of the Middle Ages and the example they are setting to the world to-day in showing how the public welfare may be promoted by efficient municipal action, in proving by their experience that it is not necessary to pay tribute to "robber barons" of the present day to secure a high degree of public welfare.

As we sail along the Rhine to-day we see where alongside some of the old castles their baronial occupants erected chapels to salve their consciences and insure their souls against future conflagrations; but these did not avail to save them and their strongholds from passing away with the evolution of a new civilization. On the other hand some of these old-time barons also underwent a process of evolution. Instead of marauders they became public protectors and earned their living by waging warfare against common enemies.

I do not think our modern "barons" can thwart the process of evolution by gifts of libraries and picture galleries. They may, however, by transforming their methods, gain salvation like those old-time barons who survived—by becoming leaders in real public service.

C. W. B.

Strassburg, Germany, July 4, 1910.

AN INTERNATIONAL MUNICIPAL CONGRESS AND exposition will be held at Chicago on Sept. 18-30, 1911. For this purpose the Coliseum, Wabash Ave., 14th and 16th Sts., and the Armory, Michigan Ave. and 16th St., together with adjoining exterior exposition-grounds, will be utilized. Delegates from all important American and foreign cities and members of numerous national and international organizations devoted to municipal government and civic improvement will be invited. A large exhibit is proposed. It is stated that the Congress and Exposition has been endorsed by the City Council of Chicago, and has been participated in by a number of Chicago organizations. Mr. Edward H. Allen is general manager of the Exposition, with offices in the Great Northern Bldg., Chicago.

Comparative Sections of Thirty Retaining Walls and Some Notes on Retaining Wall Design.

By FRANK H. CARTER,* Assoc. M. Am. Soc. C. E.

Having occasion recently to design retaining walls both for what might be termed ordinary as well as for peculiar conditions, the writer hurriedly gathered what notes he had at hand, and caused a search to be made for literature concerning existing types, with the result that he determined, when he could take the time, to compile more complete information than he could find in print concerning retaining walls already built, believing that this type of structure, if no other, warranted as perfect a knowledge of past construction as it is possible for the designer to have at his command.

The new material was gathered largely by correspondence with designers of walls known personally to the writer. Drawings of all of these walls were made to the same scale and blue prints sent to most of the engineers interested, who very generously corrected and annotated them. Thanks are due to the engineers who made these additional contributions to the existing information on retaining walls, the design of which at best must always be uncertain either structurally or economically. Special credit should be given Prof. Milo S. Ketchum for use of material from his excellent work "Walls, Bins and Grain Elevators," supplemented by correspondence with the writer.

The results are shown by the drawings Figs. 1, 2 and 4, the latter figure showing three retaining-wall structures designed by the writer for the Cambridge Main Street Subway. It is to be regretted that no information is at hand concerning the character of the material in which the walls as shown in Figs. 1 and 2 are built, except what few notes are given on the drawings themselves.

Notwithstanding the obvious fact that there must of necessity have been a wide variance in the nature of the material used for back-filling in the different cases, there is a practical uniformity in the ratio of base to height in most of the walls. In fact, most designers are inclined to at least review designs for retaining walls on the basis of ratio of width of base to height, however elaborate or rigorous may have been the determination of lines of resistance from theoretical earth pressures.

It will be noted that a few of the sections may be (and in some cases are) classed under the head of "standards." This is particularly true of the structures representing railroad practice, from which standpoint it seems desirable to have a uniform type throughout. From a purely engineering standpoint, however, no demonstration is necessary in asserting that each retaining-wall design is a special problem to be solved on its own merits, for rarely are the conditions the same in any two cases, excepting again supports for railroad embankments, or the like.

Some remarks concerning the three types designed for the Cambridge Main Street subway may be of interest.

The Cambridge Bridge incline retaining walls rest on foundation or bearing walls which bottom is carried down through from 4 to 15 ft. of mud. The floor was designed for a car weighing 70 tons, plus impact, with concrete and steel stressed not over 600 and 12,000 lbs. per sq. in. respectively, according to the straight line formula, while the concrete steel in the side walls are stressed to 12,000 lbs. per sq. in. according to theoretical earth pressures.

The Mt. Auburn Street incline was designed for dry sand or firm clay with a possible future wall of a building on top of each retaining wall.

The Cambridge Common incline was designed purely as a gravity retaining wall, and may be compared directly with the types shown in Figs. 1 and 2.

The retaining walls for the Cambridge Main Street subway were designed according to the commonly accepted theories of Rankine and Coulomb, with a surcharge of 500 lbs. per sq. ft. The theoretical pressures developed by Rankine and Coulomb are probably too great at least by 100%. However, the uncertainty of foundations for gravity types generally offsets any factor of security resulting from excessive assumptions in regard to earth pressures. It has been well said that retaining walls usually stand except for insufficient or poor foundations.

The formulas used are given below, with some diagrams facilitating their application.

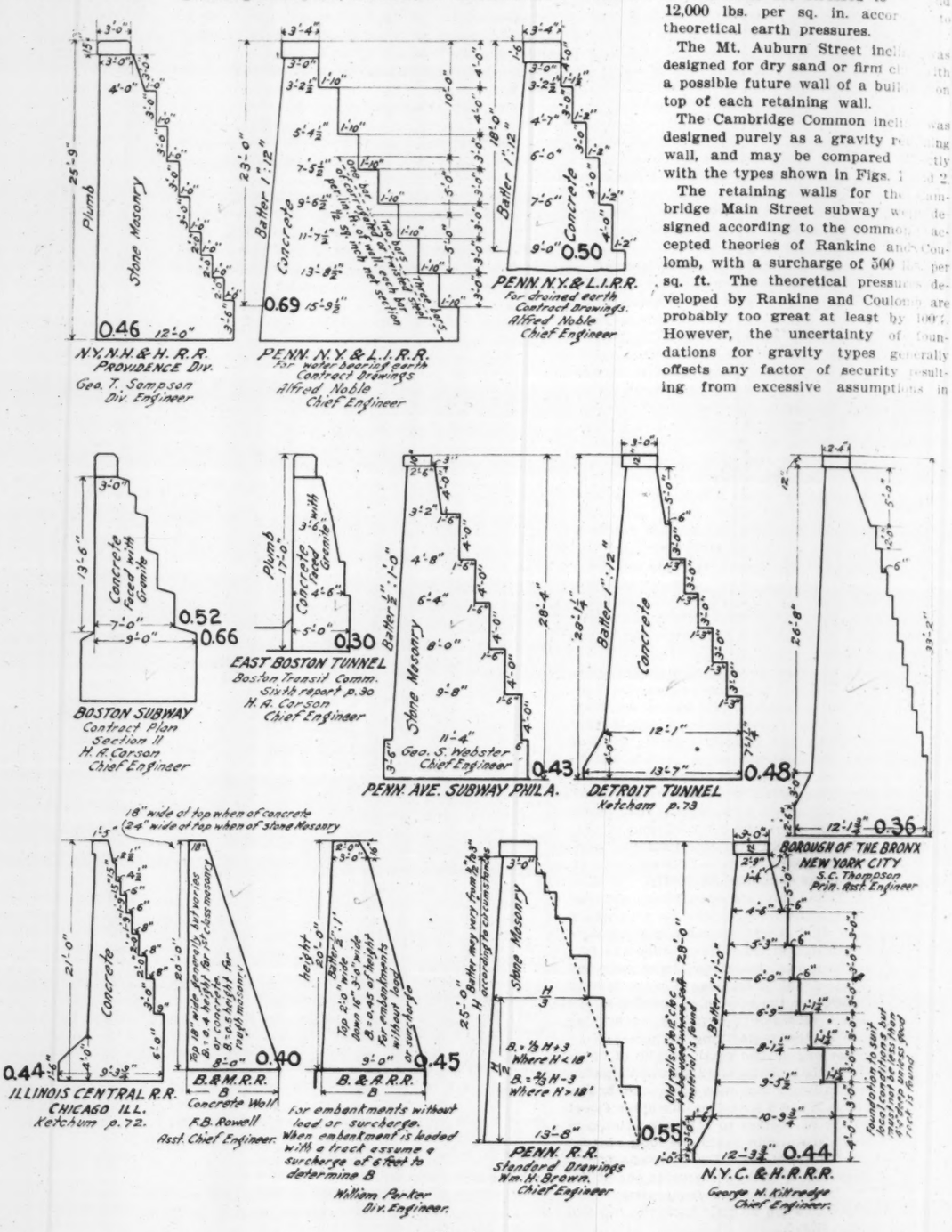

N.Y.N.H.&H. R.R. PROVIDENCE DIV. Geo. T. Sompson Div. Engineer
PENN. N.Y.&L.I.R.R. for water bearing earth Contract Drawings Alfred Noble Chief Engineer
PENN. N.Y.&L.I.R.R. for drained earth Contract Drawings. Alfred Noble Chief Engineer
BOSTON SUBWAY Contract Plan Section 11 H.A. Corson Chief Engineer
EAST BOSTON TUNNEL Boston Transit Comm. Sixth report p. 30 H.A. Corson Chief Engineer
PENN. AVE. SUBWAY PHILA. Geo. S. Webster Chief Engineer
DETROIT TUNNEL Ketchum p. 73
BOROUGH OF THE BRONX NEW YORK CITY S.C. Thompson Prin. Asst. Engineer
ILLINOIS CENTRAL R.R. CHICAGO ILL. Ketchum p. 72.
B.&M.R.R. Concrete Wall F.B. Powell Asst. Chief Engineer
B.&A.R.R. for embankments without load or surcharge. When embankment is loaded with a track assume a surcharge of 6 feet to determine B William Parker Div. Engineer
PENN. R.R. Standard Drawings Wm. H. Brown Chief Engineer
N.Y.C.&H.R.R.R. George H. Kittredge Chief Engineer

Fig. 1.

FIGS. 1 AND 2. TWENTY-SEVEN DESIGNS OF (All drawn to the same scale. The heavy upright

Theoretical Earth Pressures.

1. RESULTANT PRESSURE.—Using the following notation:

*Designing Engineer, Cambridge Main Street Subway, Boston Elevated Ry. Co., 2 Central Square, Cambridge, Mass.

P_1 = resultant earth pressure normal to back of wall,
w = weight of earth, in pounds per cubic foot,
h = height of wall, in feet,
θ = angle between back of wall and horizontal,
ϕ = angle of natural slope of material,
δ = angle between surface of surcharge and horizontal.

When $\delta = \phi$, i. e., when surcharge lies at angle of repose,

$$P_1 = \frac{1}{2} w h^2 \frac{\sin^2(\theta - \phi)}{\sin^3 \theta}$$

When $\delta = \phi$ and $\theta = 90°$, i. e., back of wall vertical,

$$P_1 = \tfrac{1}{2} w h^2 \cos^2 \phi.$$

When $\delta = 0$ and $\theta = 90°$,

$$P_1 = \tfrac{1}{2} w h^2 \tan^2 (45 - \tfrac{1}{2} \phi),$$

which is the well-known expression first deduced by Coulomb in 1773, and so admirably set forth by Prof. Merriman in "A Text-book on Retaining Walls and Masonry Dams." This is equal to

$$P_1 = \frac{1}{2} w h^2 \left(\frac{1 - \sin \phi}{1 + \sin \phi} \right)$$

as given by Rankine.

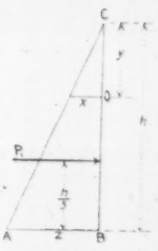


Fig. 3.

2. PRESSURES PER FOOT DEPTH.—Referring to the sketch Fig. 3, where the ordinates x represent pressures per square foot, we have

$$P_1 = \frac{1}{2} h z, \text{ or } z = \frac{2 P_1}{h}$$

The pressure per square foot at depth y from the top is P_2,

$$P_2 = y \frac{z}{h} = \frac{2 P_1 y}{h^2}$$

Substituting in this formula the value of P_1 as above we obtain $P_2 = wy \tan^2 (45 - \frac{1}{2} \phi)$.

3. SIMPLIFIED FORMULAS.—Taking the top of earth level and a live-load surcharge of 500 lbs. per lin. ft., the formula for pressure per square foot at any depth h is

$$P_2 = (wh + L)\left(\frac{1 - \sin \phi}{1 + \sin \phi} \right) = (wh + 500) Z$$

With $\phi = 20°$, for soft clay, $Z = 0.490$
$\phi = 30°$, for sand or backfill, $Z = 0.333$
$\phi = 40°$, for hard gravel or clay undisturbed, $Z = 0.217$

Taking w as 110 lbs. per cu. ft., and Z as given above, the simplified formulas are:

$\phi = 20°$	$P_2 = 53.9\ h + 245$
$\phi = 30°$	$P_2 = 36.63\ h + 166.5$
$\phi = 40°$	$P_2 = 23.87\ h + 108.5$

Without surcharge the last term in each formula of course, disappears, and we have approximately,

for $\phi = 20°$,	$P_2 = 54\ h$
$\phi = 30°$,	$P_2 = 37\ h$
$\phi = 40°$,	$P_2 = 24\ h$

The formulas without surcharge are represented graphically in Fig. 5, for six angles of repose, from 20° to 45°, with w taken as 125 lbs. per cu. ft. The formulas with surcharge are represented in Fig. 6 for the extreme values $\phi = 20°$ and $\phi = 40°$, with w taken as 110 lbs. per cu. ft. On the latter sheet are given also the curves for *passive* earth pressure, or abutting power of the earth.

The resultant or total earth pressures, and the positions of line of thrust above base, for w = 110 lbs. per cu. ft. plus surcharge of 500 lbs. per sq. ft., are shown graphically in Fig. 7.

In designing the Cambridge Main St. subway walls w was taken at 110 lbs. per cu. ft.

In the computations for the subway walls the writer was ably assisted by Wm. T. Shaw, Assoc. M. Am. Soc. C. E.

The Cambridge Main Street subway walls were built by the Hugh Nawn Contracting Co., for the Boston Elevated Railway Co., with Geo. A. Kimball, M. Am. Soc. C. E., Chief Engineer Boston Elevated Ry. Co., the writer as Designing En-

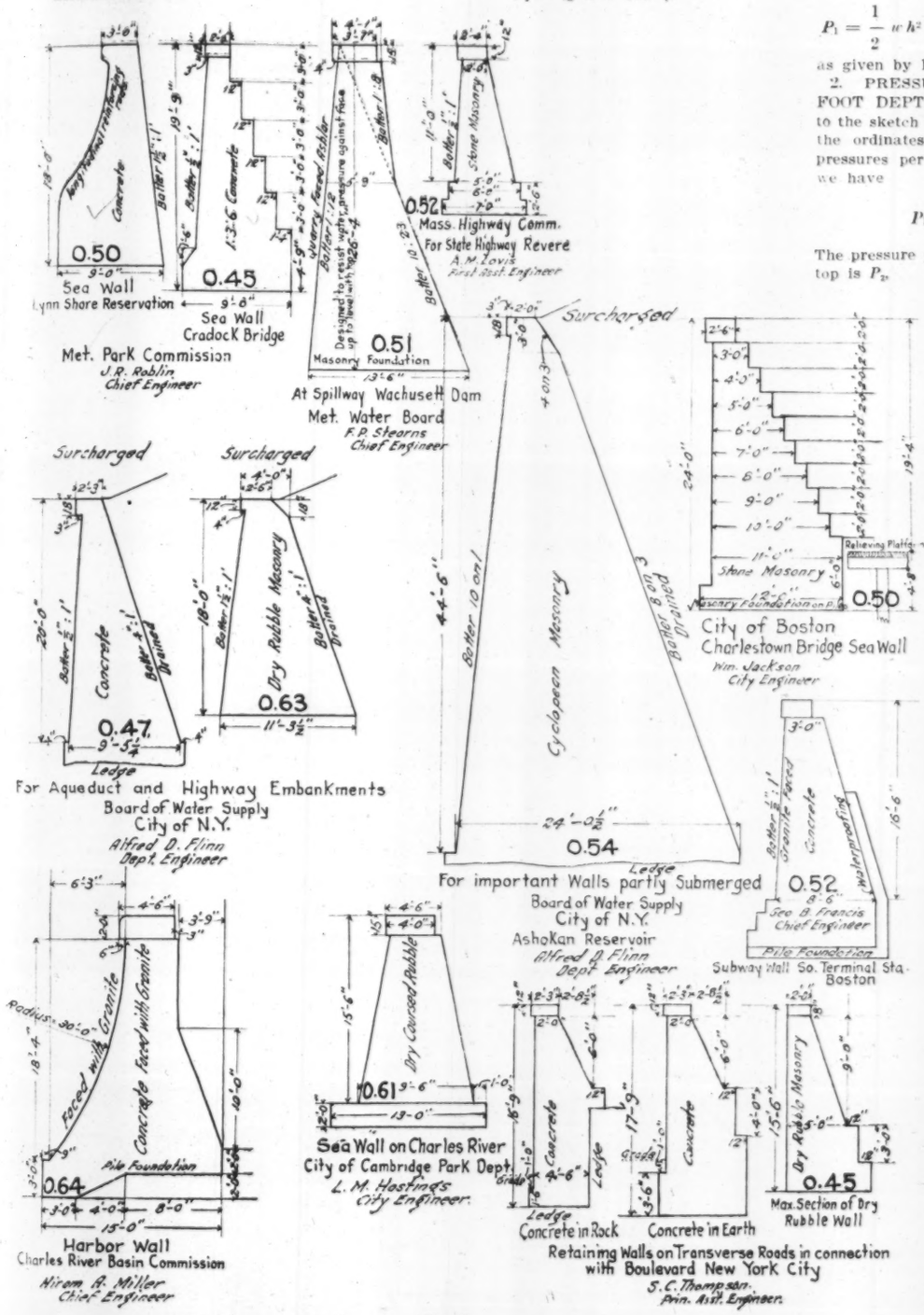


Fig. 2.

RETAINING WALL FROM ACTUAL PRACTICE.
(number on each sketch gives ratio of base to height.)

P_2 = pressure per square foot at depth y, then the formula is,

$$P_1 = \frac{\frac{1}{2} w h^2 \sin^2 (\theta - \phi)}{\sin^3 \theta \left(1 + \sqrt{\frac{\sin \phi \sin (\phi - \delta)}{\sin \theta \sin (\theta - \delta)}} \right)^2}$$

When $\delta = 0$, i. e., when top surface is level,

$$P_1 = \frac{1}{2} w h^2 \frac{\sin^2 \frac{1}{2} (\theta - \phi)}{\sin \theta \sin^2 \frac{1}{2} (\theta + \phi)}$$

gineer, Mr. Fred. B. Edwards and Mr. Robt. B. Farwell, Division Engineers, in charge of construction.

Statistics of Railways in the United States for the Year Ending June 30, 1909.*

MILEAGE.—On June 30, 1909, there was a total single-track railway mileage in the United States of 236,868.53 miles, indicating an increase of 3,215.18 miles over the corresponding mileage at the close of the previous year.

Substantially complete returns were rendered to the Commission for 235,402.09 miles of line operated, including 9,396.35 miles used under trackage rights. The aggregate mileage of railway tracks of all kinds covered by operating returns was 342,351.24 miles. This mileage was thus classified: Single track, 235,402.09 miles; second track, 20,949.41; third track, 2,169.55; fourth track, 1,453.56; yard track and sidings, 82,376.63.

The number of railways for which mileage will be included in the report is 2,196. During the year railway companies owning 2,706.56 miles of line were reorganized, merged, or consolidated.

In addition, the returns of companies classed as switching and terminal covered a total mileage owned on June 30, 1909, of 4,007.36 miles, of which 1,622.85 miles were assigned as main track and 2,384.51 as yard track and sidings.

EQUIPMENT.—There were 57,212 locomotives in the service of the carriers on June 30, 1909, indicating an increase of 479 over corresponding returns for the previous year. Of the total number of locomotives, 13,317 were classified as passenger, 33,935 as freight, and 8,837 as switching, and 1,123 were unclassified.

The total number of cars of all classes was 2,218,280, or 12,901 less than on June 30, 1908. This equipment was thus assigned: Passenger service, 45,584 cars; freight service, 2,073,606; and company's service, 99,090. The figures given do not include so-called private cars of commercial firms or corporations.

It appears that the average number of locomotives per 1,000 miles of line was 243, and the average number of cars per 1,000 miles of line was 9,423. The number of passenger-miles per passenger locomotive was 2,185,877, and the number of ton-miles per freight locomotive was 6,447,708.

The returns indicate that the number of locomotives and cars in the service of the carriers aggregated 2,275,492, of which 2,214,907 were fitted with train brakes, an increase of 10,460 over the previous year, and 2,260,777 were fitted with automatic couplers, a decrease of 10,178. Nearly all the locomotives and cars in passenger service were equipped with both train brakes and automatic couplers. Substantially all the freight locomotives had train brakes and automatic couplers. Of the 2,073,606 cars in freight service on June 30, 1909, the number fitted with train brakes was 2,039,219, and the number fitted with automatic couplers was 2,061,473.

EMPLOYEES.—The total number of persons reported as on the pay-rolls of the steam roads of the United States on June 30, 1909, was 1,502,823, or an average of 638 per 100 miles of line. As compared with returns for June 30, 1908, there was an increase of 66,548 in the total number of railway employees. There were 57,077 enginemen, 60,349 firemen, 43,608 conductors, 114,769 other trainmen, and 44,698 switch tenders, crossing tenders, and watchmen.

The total number of railway employees (omitting 42,342 not distributed) was apportioned among the six general divisions of employment as follows: To maintenance of way and structures, 459,069; maintenance of equipment, 290,381; traffic expenses, 20,178; transportation expenses, 604,867; general expenses, 52,457; and to outside operations, 24,529.

The total amount of wages and salaries reported as paid to railway employees during the year ending June 30, 1909, was $988,323,694.

The total number of persons reported by switching and terminal companies as on their pay-rolls on June 30, 1909, was 25,985. The total amount of wages and salaries reported by this class of companies for 1909 was $17,026,264.

CAPITALIZATION. — On June 30, 1909, the par value of the amount of railway capital outstanding, according to the returns of the companies filing reports with the Commission, was $17,487,686,935. Of this amount, $13,711,867,733 was outstanding in the hands of the public, representing a capitalization of $59,259 per mile of line.

Of the total capital outstanding, there existed as stock $7,686,278,545, of which $6,218,382,483 was common and $1,467,896,060 was preferred; the remaining part, $9,801,590,390, represented funded debt, consisting of mortgage bonds, $6,942,012,066; collateral trust bonds, $1,147,377,191; plain bonds, debentures, and notes, $805,537,301; income bonds, $284,497,531; miscellaneous obligations, $316,297,240; and equipment trust obligations, $307,869,061.

Of the total capital stock outstanding, $2,766,104,427, or 35.99%, paid no dividends. The amount of dividends declared during the year (by both operating and lessor companies) was $321,071,626, being equivalent to 6.53% on dividend-paying stock. No interest was paid on $718,351,332, or 7.57% of the total amount of funded debt outstanding, omitting equipment trust obligations.

PUBLIC SERVICE.—The number of passengers carried during the year ending June 30, 1909, was 891,472,425, an increase over 1908 of 1,462,851.

The number of passengers carried one mile, or the passenger-mileage, as compiled for 1909, was 29,109,322,580.

*Slightly condensed from an official abstract of the Twenty-second Annual Statistical Report of the Interstate Commerce Commission; revised returns may slightly affect some of these advance figures before final publication. Except where specifically mentioned, the statements do not include data from reports of companies classed as switching and terminal.

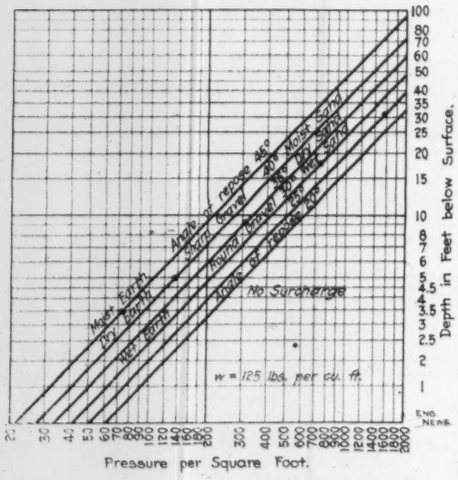


Fig. 5. Retaining-Walls: Pressure Per Square Foot at Any Depth.

(Computed for wall with vertical back, no surcharge, earth weighing 125 lbs. per cu. ft. For any other weight of earth, reduce or increase the pressure in direct proportion.)

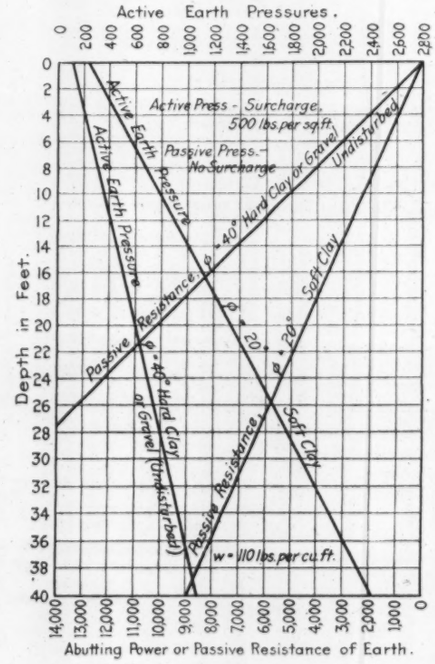

Active Earth Pressures.
Depth in Feet.
Active Press - Surcharge, 500 lbs. per sq. ft.
Passive Press. - No Surcharge
Undisturbed
Soft Clay
w = 110 lbs. per cu. ft.
Abutting Power or Passive Resistance of Earth.

Fig. 6. Active and Passive Pressures Against Retaining Walls. Pressure Per Square Foot at Any Depth.

(Computed for wall with vertical back, earth weighing 110 lbs. per cu. ft., and surcharge of 500 lbs. per sq. ft. *Passive earth pressures* given for unsurcharged condition.)

Formulas:

Active Pressure	$P_1 = 54\ h + 245$	for 20°
	$P_1 = 24\ h + 108$	for 40°
Passive Pressure	$P_1 = 224\ h$	for 20°
	$P_1 = 508\ h$	for 40°

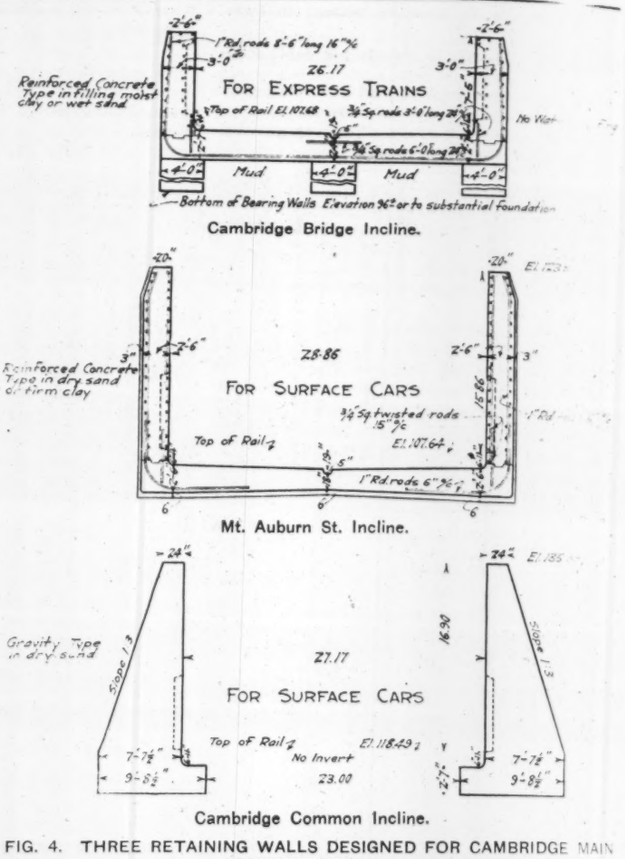


FIG. 4. THREE RETAINING WALLS DESIGNED FOR CAMBRIDGE MAIN STREET SUBWAY.

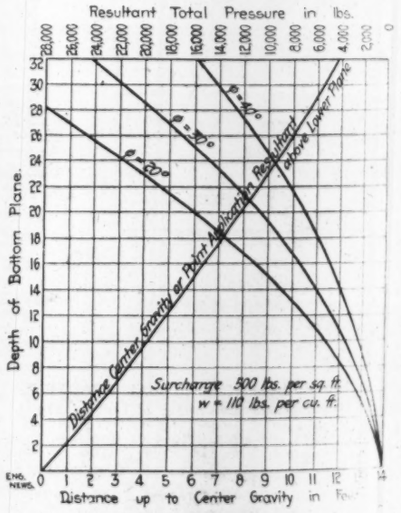

Resultant Total Pressure in lbs.
Depth of Bottom Plane.
Surcharge 500 lbs. per sq. ft.
w = 110 lbs. per cu. ft.
Distance up to Center Gravity in Ft.
ENG. NEWS.

Fig. 7. Retaining-Wall Thrust for Surcharged Walls.

(For earth, w = 110 lbs. per cu. ft. Surcharge = 500 lbs. per sq. ft.)

The number of tons of freight shown as carried (including freight received from connections) for the year ending June 30, 1909, was 1,556,559,741, an increase of 29,557,051 tons over the previous year.

The ton-mileage for the year ending June 30, 1909, was 218,502,986,929 ton-miles, an increase over 1908 of 421,432,127.

The average receipts per passenger per mile, as computed for the year ending June 30, 1909, were 1.928 cts.; the average receipts per ton mile, 0.763-ct. The passenger service train revenue per train-mile was $1.26.958; the freight revenue per train-mile was $2.76.450. The average operating revenues per train-mile were $2.16.789. The average operating expenses per train-mile were $1.43.370. The ratio of operating expenses to operating revenues was 66.16%.

REVENUES AND EXPENSES.—It should be noted that the following figures under the heading of revenues and expenses exclude returns for a few small roads because of deficiencies in their reports. For the year ending June 30, 1909, the operating revenues of the railways in the United States (average mileage operated, 232,981.11 miles) were $2,418,677,538; their operating expenses were $1,599,443,410. The corresponding returns for 1908 (average mileage operated, 227,257.02 miles) were: Operating revenues, $2,393,805,989; and operating expenses, $1,669,547,876. The following figures present a statement of the operating revenues for 1909 in detail:

Freight revenue	$1,677,614,678
Passenger revenue	563,609,342
Mail revenue	49,380,783
Express revenue	59,647,022
Excess baggage revenue and milk revenue (on passenger trains)	13,694,171
Parlor and chair car revenue and other passenger-train revenue	3,989,612
Switching revenue	21,599,256
Special service train revenue and miscellaneous transportation revenue	7,833,852
Total revenue from operations other than transportation	19,756,577
Joint facilities revenue—Dr.	500,301
Joint facilities revenue—Cr.	2,052,540
Total operating revenues	$2,418,677,538

The operating revenues averaged $10,381 per mile of line.

Operating expenses, as assigned to the five general classes, were:

Maintenance of way and structures	$308,450,105
Maintenance of equipment	363,912,886
Traffic expenses	49,287,148
Transportation expenses	814,088,149
General expenses	63,677,378
Total operating expenses (including $27,744 undistributed)	$1,599,443,410

The operating expenses averaged $6,865 per mile of line.

ACCIDENTS.—In their annual reports to the Interstate Commerce Commission, carriers have included returns for casualties to passengers, employees, trespassers, and other persons. The following figures are therefore not comparable with details in the Commission's Accident Bulletins, based on monthly reports, since the latter relate chiefly to casualties to passengers and to employees while on duty on or about trains.

The total number of casualties to persons on the railways for the year ending June 30, 1909, was 104,348, of which 8,722 represented the number of persons killed and 95,626 the number injured. Casualties occurred among three general classes of railway employees, as follows: Trainmen, 1,344 killed, 29,118 injured; switch tenders, crossing tenders, and watchmen, 93 killed, 507 injured; other employees, 1,173 killed, 45,381 injured. The casualties to employees coupling and uncoupling cars were: Killed, 155; injured, 2,382. The casualties connected with coupling and uncoupling cars are assigned as follows: Trainmen killed, 137, injured, 2,271; switch tenders, crossing tenders, and watchmen killed 4, injured 35; other employees killed 14, injured 76.

The casualties due to falling from trains, locomotives, or cars in motion were: Trainmen killed 295, injured 4,433; switch tenders, crossing tenders, and watchmen killed 1, injured 56; other employees killed 51, injured 494. The casualties due to jumping on or off trains, locomotives, or cars in motion were: Trainmen killed 84, injured 4,135; switch tenders, crossing tenders, and watchmen killed 6, injured 64; other employees killed 42, injured 487. The casualties to the same three classes of employees in consequence of collisions and derailments were: Trainmen killed 389, injured 3,159; switch tenders, crossing tenders, and watchmen killed 1, injured 20; other employees killed 70, injured 515.

The number of passengers killed in the course of the year 1909 was 253 and the number injured 10,311. During the previous year 381 passengers were killed and 11,556 injured. There were 86 passengers killed and 4,805 injured because of collisions and derailments. The total number of persons other than employees and passengers killed was 3,859, injured 10,309. These figures include the casualties to persons trespassing, of whom 4,944 were killed and 5,759 were injured. The total number of casualties to persons other than employees from being struck by trains, locomotives, or cars was 4,647 killed and 4,609 injured. The casualties from this cause were: At highway crossings, passengers killed 2, injured 3; other persons killed 733, injured 1,830; at stations, passengers killed 30, injured 67, other persons killed 431, injured 517; at other points along track, passengers killed 1, injured 12, other persons killed 3,450, injured 2,180. The ratios of casualties indicate that 1 employee in every 576 was killed and 1 employee in every 20 was injured. With regard to trainmen—that is, enginemen, firemen, conductors, and other trainmen—it appears that 1 trainman was killed for every 205 employed and 1 was injured for every 9 employed.

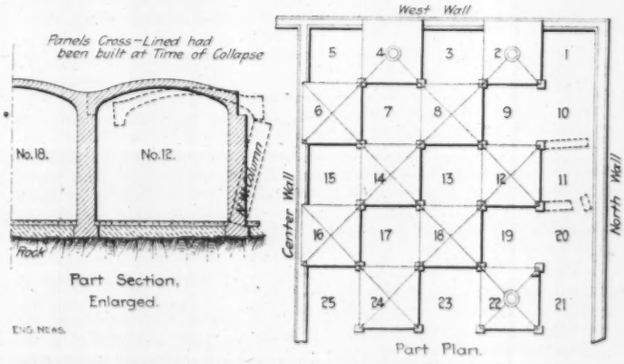
In 1909, 1 passenger was killed for every 3,523,606 carried, and 1 injured for every 86,458 carried. For 1908 the figures show that 2,335,983 passengers were carried for 1 killed, and 77,017 passengers were carried for 1 injured. With respect to the number of miles traveled the figures for 1909 show that 115,056,611 passenger-miles were accomplished for each passenger killed, and 2,823,133 passenger-miles for each passenger injured. For 1908 the figures were 76,332,905 passenger-miles for each passenger killed, and 2,516,687 passenger-miles for each passenger injured.

The total number of casualties to persons reported by switching and terminal companies [not included above—Ed.] for the year ending June 30, 1909, was 1,077, of which 102 represented the number killed and 975 the number injured. These casualties occurred among the following classes: Employees killed 49, injured 845; passengers killed 1, injured 22; other persons killed 52, injured 108. The corresponding figures for 1908 were, total number of casualties, 1,129, of which 125 represented the number killed, and 1,004 the number injured. These casualties occurred among the following classes: Employees killed 65, injured 880; passengers killed 2, injured 36; other persons killed 58, injured 88.

Collapse of Concrete Filter Roof at Owen Sound, Ont., from Premature Removal of Forms.

On July 13, 1910, one of the columns of the concrete groined arch roof to the filter beds in course of construction at Owen Sound, Ont., collapsed while the centering beneath was being removed, severely injuring two men. From all accounts the accident seems to be one more added to the great number for which premature removal of forms is responsible, and on that account we think that the accident should be put on record if for no other reason than to show that even at this late day there are contractors who are inexperienced or careless enough not to regard the time element in form removal.

The cover of the sand-filter beds at Owen Sound is composed of 130 separate groined concrete arches, each arch supported by four concrete columns, each 18 ins. sq. and 9 ft. in height. The general layout and section of the portion of the structure near where failure occurred is shown in the accompanying drawing. The span



LAYOUT AND ELEVATION OF CONCRETE GROINED ARCH ROOFS ON FILTER, OWEN SOUND, ONT.

(Panel 12 collapsed when forms were removed.)

of each arch is 11 ft. 6 ins., and the rise 2 ft. 6 ins.; the crown thickness is 6 ins. and the thickness at the spring is 22 ins. The contractor had prepared ten arch forms and had completed the laying of the concrete over nine of them. On July 9, the arches had been constructed in the alternate sections shown in the figure. On July 13, at about 4 p. m., the removal of the falsework under No. 12 arch was commenced, the arch at that time being only four days old. On the southwest and the southeast corners of this arch the thrust on the columns was resisted by the two alternate arches Nos. 8 and 18, but the columns on the other two corners were standing alone without any added thrust from the other directions.

The men had almost completed the removal of the falsework when the whole structure of the arch suddenly shot out northerly in the direction of the unsupported columns, toppling them over to the north. The southwest column fell upon the floor without breaking, but the southeast column broke in two pieces, one of which pinned the contractor himself (who was supervising the work) to the side wall, and the other falling upon a workman, catching him by the foot and completely severing it close to the ankle.

The inspector on the work reports that the concrete was of the very best character, except that at the end of the structure where failure occurred it was too green to allow the removal of the supports. The specification period for removal is seven days, and the contractor removed these forms in four days without knowledge or order of the engineer. In addition to the failure due to green concrete, it is well to note that the end columns of the roof were unsupported, and that it is probable that a bending stress beyond a safe one was thrust upon the bottoms of the end columns from the load of the roof. In this connection, the computations by Mr. T. H. Wiggin in an article on groined arch roof design (Eng. News, April 7, 1910, p. 398) are of considerable interest.

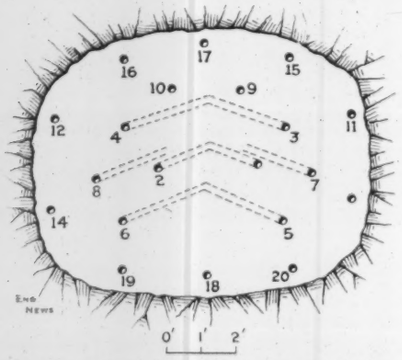
Driving the Laramie-Poudre Irrigation Tunnel in Colorado.

An interesting engineering work now in progress in Colorado is the tunneling of the range in Larimer County for the purpose of bringing water from the Laramie River into the Cache La Poudre River. This project, which is being developed by the Laramie-Poudre Reservoirs & Irrigation Co., was the conception of the late Wellington Hibbard, of Ft. Collins, who, with D. A. Camfield and S. A. Shields, organized the irrigation district, embracing about 125,000 acres of fertile and accessible land in northeastern Colorado. It is estimated that the development of this district will bring in about 5,000 families and increase the state's annual agricultural product by over $5,000,000. The first move was to secure the water rights of the several locators, thereby establishing the permanent ownership of the large supply derivable from the Laramie River. Mr. D. W. Brunton, M. Am. Soc. C. E., of Denver, Colo., is Consulting Engineer, and Mr. C. R. Hedke is Chief Engineer. The contractor is Mr. James A. McIlwee, of Cripple Creek, Colo.

The tunnel will be about 12,000 ft. long, and will have a concrete lining where the rock requires it. The cross section is approximately oval, as shown in the cut on the next page; this form facilitates rapid progress as it avoids the work of clearing and trimming corners. The hardness of the rock necessitates a large number of drill holes, and the arrangement of these is shown in the cut. Holes Nos. 1 and 2 are short-cut holes 7 ft. in from the face. Holes 3, 4, 5 and 6, are long-cut holes 9 ft. deep. Holes 7 and 8 are relief holes 8 ft. deep. Holes 9 and 10 are relief back holes 7 ft. in depth. Holes 11 and 12 are 7-ft. top side holes. Holes 13 and 14 are low side holes 7 ft. deep. Holes 15, 16 and 17 are back holes 7 ft. deep; and holes 18, 19 and 20 are lifter holes 8 ft. deep.

The ground has varied considerably. The first

work was done in red granite, changing to the form of syenite; then changing into quartzite, feldspathic quartz, and so alternating up to its present length of nearly 4,000 ft. The only difficulties worth mentioning which have so far been encountered were a soft rock vein about 400 ft. from the portal of the east end (and which had to be timbered), and a flow of water which was encountered (and was embarrassing for a few days) about 200 ft. from the portal at the west end. Each end employs two drill crews of four men each, two shifts of muckers, four men each, and a mule is employed at each end pulling eight or ten cars of broken rock. Shooting is done twice every 24 hours. Steel sheets 3½ × 7 ft. and ¼-in. thick, are employed to facilitate shoveling. The muck cars employed are the typical "Cowenhoven" tunnel type; they are lifted off from the track and put to one side, being replaced as needed, and as the loaded car is pushed back from the breast. There is a single track of 18 ins. gage; this is



Arrangement of Drill Holes, Laramie-Poudre Irrigation Canal, Colorado.

laid on the left side of the tunnel, the right side being devoted to compressed air pipes, ventilating air pipe and water pipe.

The drills used are Leyner pneumatic hammer drills, using the Edgar Allen "Stag" brand of hollow steel. In loading the 20 holes, 200 lbs. of powder varying in strength from 60 to 100% are used; usually 25 sticks of powder are loaded in each hole for the cut. The fuses are cut 10 ft. long, and it is estimated that 10 ft. of fuse will burn 7 mins. Work was commenced on Jan. 7, 1910, and 370 ft. of work had been done by Feb. 7. The tunnel is being driven at a record rate, as noted below. At the end of June the tunnel from the west portal was in 1,205 ft., and from the east portal 2,241 ft., making a total of 3,446 ft. in 165 days, or 20.9 ft. per day.

On Dec. 14, 1909, an order was placed with the Hampson-Fielding Engineering Co., of Denver, Colo., for a power plant for the tunnel, to be located on the Cache La Poudre River, 63 miles west of Ft. Collins. In spite of the inclement weather prevailing at that time of the year, work was commenced immediately. At the point selected for the power site, there were no improvements and a large amount of money had to be expended in building wagon roads to permit hauling material for erecting camp buildings, and the usual preliminary work.

A log and rock-fill dam was constructed across the Poudre River a short distance above the Poudre Falls. This dam is 140 ft. in length on top, 20 ft. wide on the bottom, and 10 ft. wide on top, giving a working height of 6 ft. from the center of the outlet pipe to the top of the dam. The spillway notch was about 100 ft. long, and 2 ft. lower than the top of the dam carrying the headgates. The dam was constructed on the bedrock of the river, the bottom course of logs being drift-bolted to the bedrock, and each succeeding course being drift-bolted to the course below. This crib was filled with the largest rocks obtainable, some of them measuring 2½ and 3 cu. yds. The bottom of the river is extremely rough and the dam is strongly supported by the irregularities together with numerous boulders which have rolled down the adjacent mountain sides. The usual form of controlling gate and scouring sluice was adopted in the construction of this dam. Immediately above the dam the river widens to a breadth of approximately 200 ft., the current tending to swing toward the west side of the river, away from the regulating gate. In order to take extra precaution, it was decided to build a boom of logs across from a point of rocks on the east bank diagonally to a point of contact between the top of the dam and the spillway notch. This acts as a diversion to deflect logs, drift wood and other flood debris from contact with the dam proper.

The power plant is served by a pipe line consisting of 8,550 ft. of 22-in. wood stave pipe, working under a total head of 278 ft. and an effective head of 218 ft. This pipe line was laid on the surface of the ground, and carried across the river at a point approximately 1,600 ft. below the dam, and thence along the west side of the river to the power-house. The pipe was constructed of 2-in. wooden staves with ⅜-in. round steel bands and malleable iron shoes to stand a pressure head at its various parts with a factor of safety of 3.5. At the lower end of the pipe line connection was made through a solid concrete anchor block with the receiver pipe, built of 3/16-in. steel plates; this is 22 ins. to 12 ins. diameter, with tapering branches to the water wheels. The various pipes were connected with Pelton water wheels: (1) a 48-in. wood-housing wheel, with a capacity of 250 brake HP. at 245 r. p. m.; (2) a 48-in. special wheel developing 125 HP. at 225 r. p. m., and (3) a special wheel developing 25 HP. at 225 r. p. m. The 250-HP. water wheel is equipped with an 80-in. driving pulley belted to a 32-in. pulley on a shaft of the alternating current generator. This wheel is provided with a special Pelton oil-pressure governor of the piston type, equipped with a self-oiling pump and oil reservoir. The wheel has an auxiliary hand control, and the governor is provided with a special returning speed mechanism, with a speed variation of 2% for a load change of 15% to 20%.

The second wheel is belted direct to a Rand air compressor having a capacity of 602 cu. ft. of free air per minute. There is an adjustable controlling device whereby the flow of air into the compressor is controlled by a special pilot valve mechanism. This governs the speed of the air compressor so that when the pressure drops 8 or 10 lbs., the automatic control will start the wheel from a state of rest. The device is a combination of safety governor and air pressure regulator, and is controlled by the air pressure from the receiver through a ¾-in. pipe. The third water wheel is used for operating a Connersville blower with a capacity of 13 cu. ft. per revolution.

The above is the plant provided for the east portal, on the Poudre River side of the tunnel. The power-house is equipped with the usual switchboard apparatus, and the current developed is transmitted across the range a distance of approximately 13,000 ft. to the Laramie side, or the west portal. The air-compressor and blowing engine at this portal are duplicates of those at the east portal, but are operated by electric motors instead of by water wheels. The current is sent over the transmission line at 2,200 volts, and the combined efficiency of the plant is given as nearly 61%.

The generator is a 150-KW. three-phase 60-cycle 2,200-volt machine running at 600 r. p. m., and provided with a 7-KW. 126-volt direct-connected exciter. The transformers at the west portal are of 2,200-488 volts, oil-cooled for power purposes, and the lighting circuits are 110 volts. There are three motors at this portal; one of 100 HP. (720 r. p. m.) for driving the air compressor, one of 20 HP. (900 r. p. m.) for driving the blower, and one of 30 HP. for driving the hoisting engine. The usual unloading devices and air receivers are provided.

The camps at both portals are well illuminated by 16-c. p. lamps in the boarding houses, bunk houses, commissaries, individual tents, power-houses and other buildings. At both portals there are fairly comfortable buildings for the men. During the construction work, the men were housed in tents, which were later replaced by frame buildings. All material, supplies and machinery were hauled in wagons from Eagleside, 15 miles west of Ft. Collins, over mountain roads by farmers' teams at a cost of $1 per 100 lbs. for the larger portion of the equipment. Work on this power plant was commenced in the middle of winter and the plant was turned over in operating condition on March 9, or in less than 90 days from the date of placing the order. It has been in continuous operation since it was started.

In regard to the progress made in driving the tunnel, we take the following information from the "Engineering and Mining Journal," condensing the matter slightly:

During May, 1910, the Laramie-Poudre tunnel was driven from two headings a distance of 825 ft. The heading from the west end was advanced 332 ft., while the heading from the east portal was advanced 513 ft., thus breaking all American records for driving a single heading in a calendar month. In January, 1909, the Cripple Creek drainage tunnel was driven 435 ft.; in January, 1908, one of the headings in the Gunnison tunnel made 449 ft., and in October, 1908, the Elizabeth tunnel (near Los Angeles) was driven 466 ft. The rock in the Cripple Creek drainage tunnel and in the Laramie irrigation tunnel is much the same, being hard, firm granite in each; in the Gunnison and the Elizabeth tunnels the rock was very much softer, and in the latter quite a large proportion of it was shale.

The rate of driving is from the official surveys and measurements of Charles R. Hedke, Chief Engineer for the Laramie-Poudre Co. Making 513 ft. in a single heading in a calendar month is quite an achievement, but when the difficulties under which the work from the western end is carried on are considered, 332 ft. for that section is almost as creditable. The Laramie tunnel is driven on a grade of 1.7% and the material removed from the west heading has to be hauled upgrade, whereas at the east heading the loaded cars run downgrade and only empty cars have to be hauled up. In addition to this the west-end workings do not run directly out into the open air on grade but are connected with the surface by a 200-ft. incline. This was done to avoid about 1,400 ft. of water-bearing rock and wash which would have drained directly down the tunnel into the heading. Even with this precaution some water seeps in and has to be pumped. When the difficulties of pumping, up-hill haulage, and hoisting through an incline are considered, it will be seen that the 332 ft. driven at the west end is a most creditable performance.

The men work under the bonus system and receive an extra amount of pay for each foot driven over 250 ft. in each calendar month.

Crushing Machines for Cyanide Plants.*

By MARK R. LAMB,† M. Am. Inst. M. E.,

The recent growth of a sentiment among cyanide-plant designers against the use of gravity stamps for the crushing preliminary to cyanidation may be said to date from the almost simultaneous perfection of the ribbed tube-mill liner and of the tall, air-agitation tank.

The first step in the resulting change of practice was the universal adoption of the tube mill for fine grinding and the use of coarse screening on the battery. This was the beginning of the surrender of supremacy by the gravity stamp; since merely the single fact that it was a more economical machine for crushing fine had retained it in favor as compared with ball mills, rolls, or steam stamps. The surrender, however, is not yet complete.

It is the universal practice to use rolls where a relatively small tonnage is to be crushed coarse, as, for example, when coarse concentration is included in the plan of treatment. Power, attendance, repairs, and first cost are smaller for the rolls, under such circumstances, than for stamps; and it is becoming daily more apparent that, with no concentration to provide for, the use of rolls and tube mills, without the complication of trommels and elevators required by concentration, is rapidly gaining favor in the eyes of the leading designers.

The next step was the use of the rapid-running Chilean mill between the gravity stamps and the tube mill, which again narrowed the field of operation of the gravity stamp while radically widening its screen aperture. Such a combination of stamps and Chilean mill offers advantages when fine concentration is necessary, since the reduction in the Chilean mill can be adjusted easily and governed by varying the screen mesh.

But even concentration is now looked at askance. One of the leaders of this metallurgy has abandoned the

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†178, 22nd St., Milwaukee, Wis.

separation and separate treatment of concentrates in the gold mill which he is operating, and uses the concentrator merely as separators of a product requiring finer grinding than the average ore. The concentrate thus obtained is continuously returned to the tube mill, only that part of it escaping to the cyanide plant which is too fine to be caught again on the tables and which is therefore in a proper condition for cyanide treatment by air agitation. Another consulting metallurgist has advised his clients to omit concentration in treating a silver ore which is quite similar to that of Pachuca. At this point the old-style Chilean roller mill has begun to come into its own, as, although expensive in first cost, the costs for power, labor and repair are very low.

The next step in point of time and the most radical in apparent daring was the abandonment of amalgamation of every product except the concentrates by the Goldfield Consolidated Co. in treating a high-grade, free-milling gold ore. Undoubtedly there were numerous reasons for this step; but not the least of these was the loss of gold through the operations of the illicit gold buyers. The fact that the ore is so rich and the concentrate so very high in grade makes the change unusually noteworthy.

Whether the above-described scheme of sliming the concentrate and treating it with the balance of the pulp should be recommended in the Goldfield case, can only be decided by careful experiment. It is only fair to remember that the Meyer & Charlton last year experimented with a view to omit all amalgamation, both on mill plates and on shaking tables, recovering all the gold in the cyanide works. This was reported a failure, but details are lacking. In any case, the Goldfield plant at present uses the stamps merely for coarse crushing, a work which probably could be done more cheaply with rolls, if the plant were re-designed; and the necessary machinery would cost less. Even steam stamps would be cheaper than gravity stamps, but the fuel cost would have to be compared with that of local electric power.

In considering the steam stamp, it should be borne in mind that there is no practical crusher of this type on the market with a capacity between the small Tremain, with its 20 or 30 tons daily to 3-mesh, and the stamp of the Lake Superior district, which crushes from 500 to 800 tons. This significant lack has dawned on several manufacturers at the same time; and the mine owner with reasonable fuel cost no doubt soon will have offered to him a simple steam stamp of from 100 to 200 tons capacity, the cost of which will leave him little reason to prefer the gravity stamp.

The literature concerning the steam stamp is strangely meager. There are scores of these monster machines in the copper country, and no secret is made of the operating and repair costs. The differences between the products of the various manufacturers, as well as between the simple and the compound stamp, are thoroughly well known, and the opinions of those locally in a position to know are in singular accord, particularly as regards the relative efficiency of the compound and the simple stamp.

While, theoretically, the former has the advantage to the extent of 27%, while with one voice they urge, as more than offsetting the saving of fuel, the disadvantages of the more complicated machine—difficulties of repairs and greater loss of time in tearing down to replace a broken cylinder head or piston rod. Moreover, while one man can attend to the operation of a simple stamp, three are required on some of the compound stamps. On account of mass copper, a "human" feeder is required to be in constant attendance on these large units; but an automatic feeder will be provided with the smaller units designed for crushing gold and silver ore.

For soft, or even for hard but friable ore, the cyanider should be encouraged by the success of the pebble mill (taken from the cement industry), to adopt one more machine from the same source—namely, the ball-tube mill. The disadvantages of the ordinary ball mill which has been tried here and there on ore—its expensive liners and screens when used for fine crushing—are entirely avoided in the ball-tube mill. What remains is merely a shell on trunnions with simple ribbed lining and a load of forged-steel balls. It may be of interest to state here that a 7 × 7-ft. ball-tube mill weighs 54,000 lbs. without its 12-ton charge of steel balls. The mill with balls sells for about $4,300, requires 140-HP., and crushes 260 tons of dry clinker in 24 hrs. from 2-in. to 20-in. mesh or a proportionately larger quantity to a coarser mesh.

Clinker, as regards hardness, may be considered a rather soft ore, though in thinking of the work done in the mill, any piece of ore is soft under the blow of a 6-in. steel ball weighing 30 lbs. and falling 5 or 6 ft. In a contribution to the "Mining Journal" of Sept. 4, 1909, Mr. W. Von Bernewitz gives interesting data on dry grinding in ball mills. He breaks 120 tons in 6 hrs. in a No. 5 Gates, and puts the 3-in. product through three No. 5 ball mills to 27 mesh. This dry grinding costs 4.2 cts. per ton, each mill requiring 16 to 20 HP. The wear is 3.5 ozs. of steel per ton of ore ground.

It will be seen from all the foregoing that there is a choice among three machines to replace gravity stamps advantageously in cases where neither concentration nor amalgamation is necessary. The simple nature permitting such treatment is attributed to an increasing variety of ores. In fact, except for the occasional manganese silver ore, it might be said that cyaniding is a purely mechanical process, requiring a chemist merely as a form of insurance. A simple crushing and grinding plant would consist of breaker, ball-tube mill, classifier and pebble-tube mill, in which attendance and skill requirements would be reduced to a minimum. If rolls are preferred to the ball-tube mill, their substitution does not affect the other machines. If fuel is advantageously cheap, the plant will consist of crusher, steam stamp, classifier and tube mills. For small plants or with unskilled labor the slow Chilean mill has advantages. In either case, there is no work for the gravity stamp which cannot be done better by either of the other coarse crushers.

We may rest our case against the gravity stamp in general terms as follows: Large tonnages of hard ore are crushed advantageously to $^3/_{16}$-in., or coarser, with steam stamps. Steam consumption, labor, repairs, and first cost are smaller than the corresponding items for gravity stamps. Such steam stamps are for capacities exceeding 500 tons daily. Small tonnages of hard rock are crushed advantageously with rolls, which are admittedly cheaper than gravity stamps in first cost, repairs, labor, and power, if they are not expected to crush too fine, and are not complicated with screens and elevators—as they need not be for feeding tube mills.

Large ball-tube mills are available for reducing 3-in. ore to a size suitable for feeding pebble-tube mills in one operation with no screening. Scores of these mills are in use for crushing hard, glassy clinker. The objection may be urged that tough quartz is very different from clinker. So it is; but the same objection was urged only a few years ago against the use of the pebble-tube mill and was found to be groundless, except that the capacity of that mill is smaller with quartz than with clinker. Finally, small steam stamps will undoubtedly be at the disposal of the metallurgist within a short period. This machine needs no explanation or justification, since it will merely fill the gap in sizes of a type of mechanism, the merits of which have been proved in practice.

The entire mechanics of the cyanide process have changed radically within a short period. While we in America have wondered and worried because South Africans were building heavier stamps than we could be persuaded to use, perhaps, after all, we have been luckily slow.

A PREMATURE EXPLOSION OF A BLAST killed five men at the quarry of the Nazareth Portland Cement Co., at Nazareth, Pa., on July 18.

GRAIN DUST EXPLOSIONS are given as the causes of two serious fires in Chicago on July 24, one at the plant of the Northwestern Malt & Grain Co. and the other at a brewery. The total loss is estimated to be $300,000.

TWO EXPLOSIONS FOLLOWED BY FIRE destroyed four manufacturing plants in Cincinnati, Ohio, on July 24. The first explosion occurred in the plant of the Cincinnati Ball Crank Co. and is supposed to have been caused by natural gas. The fire following the explosion required all the fire-fighting facilities of the city and did damage estimated at $250,000.

AN EXPLOSION OF POWDER IN A TUNNEL killed eleven men at La Tuque, Que., on July 26. The explosion was the result of an attempt by one of the workmen to open a can of powder with an axe, causing the can to explode and setting fire to a train of powder leading into a tunnel where 15 men were at work on the new Transcontinental Ry. line.

A PREMATURE EXPLOSION IN A 12-IN. GUN at Fort Monroe, Va., killed 11 enlisted men and wounded 6 others, including Second Lieutenant C. L. Van Deusen, of the Coast Artillery. The accident occurred on July 21 during target practice on floating targets. General Crozier, Chief of Ordnance, it is reported, states the cause of the accident to have been due to the firing of the gun before the breech mechanism had been locked, which in turn was due to the failure of the safety device which should prevent the possibility of the gun's being fired before the breech is locked.

A POWDER MAGAZINE EXPLODED, July 11, at Sand Point, Ont., causing the deaths of three workmen and seriously injuring four others. The magazine was the property of the Dominion Explosives Co., and its contents were a new product in an experimental stage, none having yet been put upon the market.

A powder magazine belonging to the Standard Plate Glass Co., at Cabot, Pa., containing 1,000 lbs. of dynamite and 5,000 lbs. of blasting powder, exploded on July 12. One person was killed and about twenty others injured.

AN EXPLOSION OF GASOLINE on board of a coastwise schooner occurred in San Juan, Porto Rico, harbor on July 20. The explosion blew several hundred five-gallon cans of gasoline into the water, where they were recovered by American marines from the Naval Station. The cans were piled upon the naval station wharf where a second explosion soon occurred which for a time threatened to destroy all of the government buildings there.

EXTENSIVE FOREST FIRES have been burning for several days in Minnesota, Wisconsin, Michigan, Manitoba and more recently in Alaska. Great quantities of standing timber have already been destroyed.

THE DRAWBRIDGE ACCIDENT at Michigan City, Ind., which was noted in our issue of July 7, occured to a 94-ft. single-leaf highway bascule bridge of the fixed trunnion type, carrying Franklin St. across the river. The trusses were of the half-through type, 10 ft. deep, with floor beams between the posts. The bridge was about half open (and moving upward) when the stern of the steamer struck the bottom chord of the first panel adjacent to the special panels carrying the trunnion, weakening the trusses so that the bridge dropped at this point, folding up along the panel joint in the top chord. In falling, it struck a tug boat and carried it to the bottom of the river. The contract for removing the bridge wreckage and the tug was let to the Great Lakes Dredge & Dock Co., at $4,500. It required three days of ten working hours to remove the bridge; the tug (which was a total wreck) was partly raised and dragged to shoal water, out of the way of navigation, in about five hours. Mr. Harry M. Miles, City Civil Engineer, states that the foundations, trunnions, trunnion supports, counterweights and machinery of the bridge, are all in good condition, but that in all probability the superstructure will be rebuilt.

SHIFTING FREIGHT WRECKED A BRIDGE on the Pennsylvania R. R., near Auburn, Pa., on June 23. The accident was of a nature to direct special attention to the need of ample fastenings for bulky pieces of heavy freight. A gondola car loaded with eleven steel trusses and accessory bridge parts, totaling 41,600 lbs. in weight, was the second car of a freight train; while the train passed over a bridge on curve crossing the Reading tracks the trusses on the car swung out at the front and struck the second strut of one bridge truss. The bridge collapsed and six cars of the train fell, blocking the Reading tracks below; the car of trusses, however, together with the first car and the engine, reached the far side, stopping 210 ft. beyond the fallen span, while eight cars were left on the near side. The car of trusses was found to be off centers, its rear pair of wheels was derailed and part of the right-hand side was torn off; the trusses had slid out of the rear of the car as it came off the bridge. In spite of the condition of the car, a full investigation by Superintendent A. W. Moss proved the cause of the accident to be shifting of the lading to the right. Marks traced to a loosened and displaced standard of the fastening of the trusses were found several miles back of the point of accident, but a bridge of construction similar to the wrecked one, but with opposite curvature, showed no marks. The division is one of much curvature. The curve at the point of accident was 5°, compounded to 1° 30′ on the bridge. The indications are that the first disturbance of the lading occurred in picking up the car in Reading yard to place it ready for the outgoing train. It will be recalled that experiments by Col. B. W. Dunn for the Bureau for the Safe Transportation of Explosives, etc. (Eng. News, April 1, 1909) showed very high shocks to tightly-fixed lading in collisions even as light as those occurring in coupling work. The fastenings having been disturbed by the coupling the trusses were able to shift at the curve and strike the bridge. The Reading tracks were opened to traffic after half a day's closure. For re-establishing the Pennsylvania line, a temporary crossing of 28-ft. plate-girders and timber trestle was built, which was completed and opened to traffic in 2½ days after the accident.

A PECULIAR ACCIDENT.—Juan Antolin, a Spanish laborer, aged 38 years, was washed through 269 ft. of 20-in. drain pipe at Gatun Dam on the afternoon of July 4, and is recovering from the bruises he sustained. He was one of a gang at work on a floating platform keeping debris from the hydraulic fill in the west section of the dam, from being carried into the drain pipe and clogging it. He fell from the platform and although his fellow workers tried to rescue him, was carried head first into the pipe. A minute later he was

washed out of the discharge end of the pipe into the old West Diversion channel, whence he swam and was dragged ashore.—"The Canal Record," July 13, 1910.

THREE MINE RESCUE STATIONS are to be established at once under the newly created Bureau of Mines, of Department of the Interior. According to the announcement of Mr. George Otis Smith, Acting Director of the Bureau, stations will soon be established in the coal mining districts at Birmingham, Ala., Huntington, W. Va., and Wilkes-Barre, Pa. Nine stations are ultimately planned. Each station will be in charge of an experienced foreman whose duty it will be to train the miners in his vicinity in rescue work. The equipment of each station will consist of eight oxygen helmets. Miners trained in the use of these helmets will be organized into rescue corps at each mine and will be held in readiness to answer emergency calls in their own mines and when necessary in neighboring ones. At times of disaster the foreman will have command of these rescue forces. Also a trained mining engineer will be assigned to each district, who will examine into the physical conditions of the mines of his district and have general supervision over the rescue work.

AN ELECTRICAL ILLUMINATION OF MEXICO City, Mex., will be held during the coming month of September in connection with the centennial of the independence of Mexico. The Mexico Light & Power Co. estimates that about 300,000 extra incandescent lights will be burned during the whole month. Of these, 16,000 will be placed on the Cathedral, 8,000 on the front of the National Palace, and from some hundreds to some thousands on other buildings, public and private.

A 1,020-FT. DOCK to accommodate the proposed 1,000-ft. Cunard liners is planned for the port of Liverpool, Eng. It is expected that the contract will soon be let and that the dock will be ready in about three years, when the boats for which it is intended are completed.

ELECTRIC TRACTION on some of Bavarian state railway lines will replace steam, it is reported in press dispatches. The Bavarian Diet on July 21, voted $1,500,000, as a first installment to be used in construction of hydro-electric works, at Lake Walchen, to supply the railways. Further appropriations are to be made annually to extend the installation of electric traction.

A GAS-ENGINE TRANSATLANTIC LINER of 9,000 tons displacement has been ordered from the ship-building firm of Blohm & Voss by the Hamburg-American company, according to cabled reports from Hamburg. It is intended to use gasoline fuel and to secure a boat that will develop a speed of 12.5 knots per hr.

A MUNICIPAL ASPHALT REPAIR PLANT is being built by the City of Denver. It is expected that it will be put in operation on August 1, 1910. The construction of the plant is being carried on under the supervision of Mr. S. R. Murray, who was for two years in charge of a municipal asphalt repair plant at Indianapolis. The Denver plant will cost about $25,000, of which $7,500 is for land, and something over $17,000 for buildings and machinery. The capacity of the plant is sufficient to supply 1,000 sq. yds. of 2-in. surfacing per day. A popular description of the plant and illustrations is given in the "Denver Municipal Facts," the official weekly of that city, for July 16, 1910.

ESTIMATES OF THE STAND OF MERCHANTABLE timber in each township and section of the National Forest reserves in Arizona, New Mexico, Arkansas and Florida are to be made by the U. S. Department of Agriculture. It is expected that the work will extend to the close of the year 1912.

TEN TONS OF SEED FOR RESTOCKING THE National Forests are being used during the current year by the Forest Service of the U. S. Department of Agriculture. Most of the seed, it appears, is being sown broadcast in places which require restocking, largely burnt areas. The Government, has, however, no less than 24 forest nurseries with an annual productive capacity of over 8,000,000 seedlings.

WATER FOR CARLSBAD, N. M., is to be supplied from the Carlsbad irrigation project of the U. S. Reclamation Service on a five-year contract just approved by the Secretary of the Interior. The town is to pay the Government the same rate it has charged for water-supply for irrigation, which is $1.25 per acre-ft., or an approximate rate of $3.83 per 1,000,000 gallons. It is stated that this represents a net income of 8% per year on the construction charge investment.

Personals.

Mr. George W. Peck, of the Pelton Water Wheel Co., has been appointed Mechanical Engineer for the Water Department of St. Louis, Mo.

Mr. Francis E. Adams, associated with the Coffin Valve Co. of Boston, Mass., for nearly 20 years, has severed his connection with this company.

Mr. Arthur J. Wolfe, for a number of years Assistant Engineer, has been made Chief Engineer of the Scioto Valley Traction Co., with headquarters at Columbus, Ohio.

Mr. Harry B. Chamberlain, formerly at the head of the traffic department of the Erie R. R., has been made Vice-President in charge of traffic on the Tennessee Central R. R.

Mr. C. A. Tupper, formerly Manager of the publication department of the Allis-Chalmers Co., has become Manager of the Reliance Engineering and Equipment Co., of Milwaukee, Wis.

Mr. Fremont Crane, formerly a locating engineer on the Oregon Trunk Line R. R., has been appointed Surveyor, Department of the Interior, for making Indian allotments on the Colville Reservation.

Mr. Albert F. Damon, a civil engineer, of Darby, Pa., has been appointed Consulting Engineer of Chester and West Chester, Pa. Mr. Damon succeeds the late Silas G. Comfort, whose death was recorded in Engineering News of July 21.

Mr. H. B. Kirkpatrick, Assoc. M. Am. Soc. C. E., has resigned his position as Chief of the Irrigation Division, Bureau of Public Works, Government of the Philippine Islands, and has returned to the United States to engage in general hydraulic engineering work.

Mr. E. W. Grice, formerly General Superintendent of the Chesapeake & Ohio Ry., at Hinton, W. Va., has been made General Manager, with headquarters at Richmond, Va. Mr. F. I. Cabell, formerly Engineer of Maintenance of Way, has been made Chief Engineer of Maintenance of Way.

Mr. Philander Betts, M. Am. Inst. E. E., a consulting engineer, of Washington, D. C., and formerly Assistant Professor of Electrical Engineering at George Washington University, has been appointed Chief Inspector of the utilities division of the New Jersey Public Utilities Commission at a salary of $4,000.

Mr. George Sydney Binckley, M. Am. Soc. C. E., who has been connected with the British Columbia Electric Railway Co., Ltd., as Consulting Engineer and Chief Hydraulic Engineer for nearly two years past, expects to conclude his work in British Columbia in September and resume his consulting practice in Los Angeles, Cal.

Mr. Louis R. Ash, Assoc. M. Am. Soc. C. E., for several years with Mr. Ira G. Hedrick, a consulting engineer of Kansas City, Mo., has been appointed City Engineer by the Kansas City Board of Public Works. Mr. Ash succeeds Mr. James L. Darnell who will probably engage in practice as a consulting municipal engineer in Kansas City.

Mr. John A. Ockerson, M. Am. Soc. C. E., of St. Louis, Mo., a member of the Mississippi River Commission, has been appointed by President Taft to take charge of the river protection work on the Colorado River for which Congress recently appropriated $1,000,000. The overflow and erosion of the river threaten the irrigation works of the Imperial Valley, near the famous Salton Sea, as well as the valley itself.

Mr. C. J. Hogue, Assoc M. Am. Soc. C. E., of Philadelphia, Pa., left San Francisco on July 19 for Manila, P. I., where he will enter the employment of the Manila Railway Co. Mr. Hogue will have charge of surveys for a railway from Dagupan to Baguio, a distance of about 30 miles. Baguio is 5,000 ft. above sea-level and is the summer capital for officers of the Philippine Government. Other members of the party were Messrs. C. E. Meyers, C. A. Garner and W. P. Miller.

Mr. George Gilmour, M. Am. Soc. M. E., formerly Chief Engineer of the Travelers' Insurance Co., of Hartford, Conn., now a consulting engineer of New York City, has been selected by the Commission of the State of New York on Employers' Liability, Unemployment and the Causes and Prevention of Industrial Accidents, to make an investigation of factories and industrial plants in European countries and the methods there taken for the prevention of industrial accidents. His report will be the basis for possible further legislation in New York state for the betterment of industrial conditions. Mr. Gilmour left New York on July 23 and expects to be away four months.

Obituary.

Albert W. Jack, Vice-President of the Star Headlight Co., died in Rochester, N. Y., on July 20, at the age of 69 years. Mr. Jack was formerly engaged in the railway supply business.

John Sutcliffe, M. Am. Inst. M. E., died at the home of his son, Paul Sutcliffe, in Bellevue, Pa., on July 23, at the age of 73 years. Mr. Sutcliffe had long been a resident of Poughkeepsie, N. Y., where he had carried on an extensive practice in mechanical and mining engineering. One of his earliest undertakings was the Phillips Iron Works at Cold Spring, N. Y., which he built in 1863. He afterwards built several iron works in this country and Canada and was for some years with the Vallecillo Silver Mining Co. in Mexico. He was married in 1876 to Miss [illegible] E. Swart of Poughkeepsie and is survived by three sons, Paul Sutcliffe, above mentioned; Allan Sutcliffe, of New York City, and John W. Sutcliffe of Fall River, Mass. Mr. Sutcliffe was a member of the Canadian Society of Civil Engineers and of the Engineers Club of New York City.

Frederick H. Lincoln, Assoc. Am. Inst. E. E., was killed at the West Philadelphia station of the Pennsylvania R. R. on July 11. Mr. Lincoln was born in Boston, Mass., May 28, 1867. His first electrical work was with the Walworth Manufacturing Co. In 1884, he was with the Thompson-Houston Electric Co., and in 1891 with the Toledo Consolidated Street Railway Co. From here he went to the People's Traction Co., of Philadelphia, with which he remained after the consolidation with the Philadelphia Rapid Transit Co. In August, 1905, he was made Assistant General Manager and had charge of the maintenance of equipment of the entire system. He was the inventor of car appliances and left the Rapid Transit Co. last January to become Vice-President and General Manager of the Pay-Within Car Co., which controls his patents. He was prominent in the work of the American Street and Interurban Railway Association and was President of the Engineering Branch at the time of his death.

Ira G. Rawn, President of the Chicago, Indianapolis & Louisville Ry., was killed at his home in Winnetka, Ill., on July 19, by a bullet from a revolver. It has yet to be determined whether his death was by accident, suicide or murder. He was born in Ohio in 1855, and began his railway career in 1870 as a telegraph operator on what is now the Cleveland, Cincinnati, Chicago & St. Louis Ry. After rising to the positions of dispatcher and trainmaster, he became a division superintendent of the Chesapeake & Ohio Ry. in 1880, and from 1890 to 1903 was General Superintendent of the Baltimore & Ohio R. R. System. In 1903 he went to the Illinois Central R. R. as Assistant to the Second Vice-President, afterwards becoming General Superintendent of Transportation, Assistant General Manager, and General Manager. This last position he held from 1905 to October, 1909, when he was elected President of the Chicago, Indianapolis & Louisville Ry. He was a member of the American Railway Engineering & Maintenance of Way Association and served at one time upon its committee on yards and terminals.

Engineering Societies.

COMING MEETINGS.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 16-19. Annual convention at Niagara Falls, Canada. Secy., W. O. Thompson, New York Central Car Shops, East Buffalo, N. Y.

LEAGUE OF AMERICAN MUNICIPALITIES.
Aug. 23-26. Annual convention at St. Paul, Minn. Secy., John MacVicar, Des Moines, Iowa.

LAKE SUPERIOR MINING INSTITUTE.
Aug. 24-26. Annual meeting at Ironwood, Mich., and Chicago, Ill. Secy., A. J. Yungbluth, Ishpeming, Mich.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 5-9. Annual meeting at Milwaukee, Wis. Secy., W. C. Woodward, Washington, D. C.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 6-8. Annual meeting at Thousand Islands, N. Y. Asst. Secy., Walter Neumuller, 55 Duane St., New York City.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 6-9. Annual convention at Rochester, N. Y. Secy., Frank P. Foster, Corning, N. Y.

MICHIGAN GAS ASSOCIATION.
Sept. 8-12. Annual meeting on board steamer sailing from Detroit, Mich. Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 13-16. Annual convention at St. Louis, Mo. Secy., A. P. Dane, Reading, Mass.

ROADMASTERS AND MAINTENANCE-OF-WAY ASSOCIATION.
Sept. 13-16. Annual convention at Chicago, Ill. Secy., Walter E. Emery, Chief Engineer, Peoria & Pekin Union Ry., Peoria, Ill.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION.
Sept. 21-23. Annual convention at Colorado Springs. Secy., J. C. Lawler, P. O. Box 938, Colorado Springs.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 21-23. Annual convention at Rochester, N. Y. Secy., Willard Kent, Narragansett Pier, R. I.

NATIONAL IRRIGATION CONGRESS.
Sept. 26-30. Annual meeting at Pueblo, Colo. Secy., Arthur Hooker, Pueblo, Colo.